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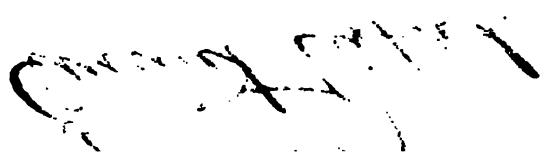

MANUAL

OF

)PERATIVE SURGERY

BY

JOHN FAIRBAIRN BINNIE, A.M., C.M. (ABERDEEN)

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SECOND EDITION, REVISED AND ENLARGED

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1906

DEDICATORY LETTER.

TWELFTH AND WYANDOTTE
KANSAS CITY, MO.

DR. ROBERT F. WEIR, New York:

Dear Dr. Weir:—Some considerable time ago you encou
me in a design to write a little book on operative surgery, in
there should be omitted, as far as possible, all description of
procedures which are ordinarily thoroughly given in the
textbooks on general surgery. You were good enough to
over and express approval of the scheme and of certain se
of manuscript submitted to you. This volume is the outco
your encouragement, and it gives me intense pleasure to have
permission to dedicate it to you.

Following out the ideas already expressed, I have omitt
reference to such subjects as amputations and ligations.
portions of genito-urinary and of rectal surgery as are fully t
in the common textbooks have been passed over in silenc
was my intention to devote considerable space to the ope
surgery of the bones and joints, but having prepared several
ters on these subjects, I found that any adequate treatm
them would require a second volume. The exigencies of
forbidding a satisfactory review of the operations on the
and joints of the extremities, I prefer to omit such entirely.
aim throughout has been to be practical: to describe ope
procedures as they are done on the living subject, instead
the normal cadaver.

For the bibliography of operative surgery, the reader is re
to the Catalogue of the Surgeon General's Library in Washi

In the preparation of this volume I have had the ben
much advice and criticism from our mutual friends, Drs.

and C. H. Mayo of Rochester, Minn. Drs. Block and Mark of this city have kindly revised the chapters on genito-urinary surgery. Drs. E. F. Robinson and R. M. Schauffler gave me much assistance in proof-reading, while my student assistant, Mr. Florian, helped me in many ways. To all these gentlemen and to those who generously placed plates and drawings at my disposal, I beg to return heartfelt thanks.

Hoping that this work of mine may never cause you to regret the encouragement given by you,

I remain,

Your friend,

J. F. BINNIE.

PREFACE TO SECOND EDITION.

The disposal of a complete edition of this book withi short space of nine months encourages me to hope tl has filled a gap. In the present edition I have taken a tage of some hints kindly thrown out by various reviewer friends. The reviewer for "The British Medical Jou noted that in discussing operations on the mastoid the operation" alone was elaborated. I have now added a de tion of the operation as I perform it, no very special instru being required. Notice has been taken of recent advanc cerebral localization, some excellent illustrations from Kr publications being inserted. Short articles on the duod and on tuberculous peritonitis have been written. Other se of the book have been revised as necessitated by the advar our art. I desire to take this opportunity to thank my colle at home and abroad for the kind reception they have give little book.

J. F. BINN

KANSAS CITY, MO.

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MANUAL OF OPERATIVE SURGERY.

PART I.—HEAD AND NECK.

CHAPTER I.

THE SKULL AND THE BRAIN.

EXPOSURE OF THE SKULL.

Many means of exposing the skull may be employed, all of which must be preceded by the shaving of a large part, or, still better, of all the scalp. In cases of open fracture, one may expose the bone sufficiently by enlarging the wound already existing. When the operation is for the removal of a foreign body lodged in the bone, a linear incision may be employed. The same incision may suffice to lay bare enough bone for the application of Doyen's perforator or a very small trephine. When a moderate sized trephine is to be used or one desires to explore the surface of the skull, the best incision is one curved in the form of a U or horseshoe. Unless specially contraindicated the open end of the U should face downwards in the direction of the blood-supply of the scalp. The knife penetrates to the bone at the first cut and the flap is rapidly and readily reflected downwards. Hemostasis must be attended to at once. Before incising the scalp some surgeons tie an elastic constrictor round the head immediately above the ears so that hemorrhage may be controlled. Lanphear attains the same end by surrounding the site of operation with a continuous chain suture, each stitch of

which includes the whole thickness of the scalp. As a rule, such precautions are needless. When operating in a region supplied by the temporal artery, it is convenient to have an assistant exert pressure thereon.

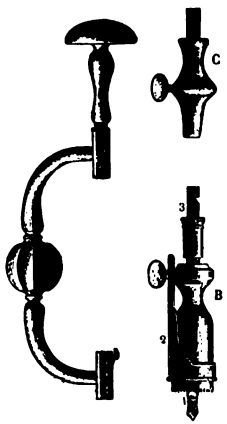


FIG. 1.—TREPHINE AND "BRACE."

B. Trephine: 1, Centre pin; 2, movable guard; 3, stem to fit into brace. C. Extra stem by which burs or drills may be attached to brace.—(*Monod and Vanverts.*)

When the U-shaped incision is preliminary to the reflection of a flap composed of skin, periosteum, and bone, hemostasis must be effected as soon as the cut is made, and the flap outlined must not be separated from the underlying bone.

METHODS OF OPENING THE SKULL.

(A) **The Trephine.**—There are two species of trephine, but of these there are many modifications:

1. The ordinary trephine is, in principle, merely a hollow steel cylinder whose lower end is provided with a saw-edge. To keep the saw-edge in position on the skull, a pin projects through the centre of the cylinder. The pin is withdrawn as soon as the trephine has cut a groove in the bone sufficiently deep to prevent it from slipping. Power is applied to the instrument through a T-shaped handle or a "brace" similar to those used by carpenters. To prevent any sudden onward movement of the instrument into the brain after the inner table of the skull is penetrated, movable guards may be fixed to the outside of the trephine. (See Fig. 1.)

FIG. 2.—(*Tiemann.*)

2. *The Galt Trephine.*—The principle of this trephine is identical with the preceding except that the cutting part of t

instrument is shaped like a truncated cone (Fig. 2). The conical shape prevents any sudden onward movement when the inner table of the skull is penetrated. The Galt trephine is most commonly used in America. The only disadvantage of this instrument is that on account of its shape it necessarily makes the button of bone removed much smaller than the hole left in the skull a matter of some importance if one intends re-implanting the bone removed.

Trephining.—Place the patient with his head resting on a sandbag and held steady by the hands of an assistant (Fig. 3). Ex-

Fig. 3.

pose the skull as already described. Make the centre pin of the trephine protrude about one-sixteenth of an inch beyond the cutting-edge and bore it into the skull at the selected site. By steady movements of the wrist, twist the trephine from left to right and right to left until it has cut a groove in the skull. Withdraw the centre pin and proceed with the trephining. As soon as the outer table of the skull is penetrated there will be less resistance to the operation and more escape of blood. As soon as

hard bone is again met, proceed with increased caution. The inner table is often very thin. After every few movements of the instrument probe the groove in the skull with the blunt end of a straight needle. If probing shows greater penetration at one part of the groove than another, lessen the pressure of the trephine at that point. The inner table is usually found divided at one place before another; when this is the case, by slightly tilting the trephine the place where penetration has already taken place is avoided while the rest of the skull is being divided. As soon as the bone is divided the resulting button is easily removed and the dura mater exposed. Along the edges of the osseous hole there will always be found projecting spicules; these must be cut away with rongeur forceps. If bleeding from the cut bone is severe, it may be stopped by sponge pressure, or, if necessary, by slightly crushing the bone between the jaws of a rongeur forceps. In the author's practice this last procedure has never failed to give satisfaction and to have no subsequent ill results. Horsley's wax (beeswax 7, almond oil 1, salicylic acid 1) applied to the bleeding bone is an efficient hemostatic agent. Should there be any intention to re-implant the button of bone removed, it must, at once, be placed in sterile water and kept at a temperature of about 100° F.

The most convenient size of trephine for ordinary purposes is one three-fourths of an inch in diameter. Smaller instruments are often useful. Trephines having a diameter much greater than one inch are useless owing to the curvature of the cranial vault.

Should it be desired to enlarge the trephine opening, this is easily accomplished by biting away the surrounding bone with rongeur forceps. Keen's forceps are excellent for this purpose (Figs. 4 and 5).

Occasionally the dura is accidentally injured by the trephine and bleeding occurs. When this is the case, enlarge the hole in the skull so that free access is obtained to the dural wound, surround any bleeding vessel by a fine suture, and close the tear in the dura.

(B) Chisel and Mallet.—Especially on the continent of Europe, the skull is frequently opened by means of a chisel. In America and England the method is not a general favorite. The writer has more than once observed severe shock result from it. Either the ordinary chisel or a gouge with a V-shaped cutting-edge may be employed. Support the patient's head on a sand-bag. Expose the skull as already described. Apply the chisel nearly parallel to the plane of the skull, and by careful use of the mallet make it cut a narrow groove in the bone. The groove is

FIG. 4.—USE OF KEEN'S FORCEPS.
Appearance of trap-door opening in skull.

gradually deepened until the inner table is divided. Those skilled in the use of the chisel for this purpose can remove or reflect a large piece of skull in a surprisingly short space of time. The chisel is very useful in operating in cases of fracture, especially of fissured fractures, where it is desired to shave away jagged and injured portions of bone. In the formation of trap-door openings through the skull, the chisel was the original instrument employed.

(C) Gigli Wire Saw.—It is desired to remove a large area of skull in one piece. Expose the skull by a U-shaped incision of

appropriate size. At each of the four corners of the area to be removed perforate the skull with a small trephine or a Doyen's perforator. With a dural separator, separate the dura from the skull along a line stretching from one trephine opening to another. Introduce an appropriately shaped grooved director to take the place of the dural separator. Pass a Gigli wire saw along the

DeVilbiss' Forceps.

Keen's Forceps.

FIG. 5.

grooved director and leave the director in place to protect the dura. With the wire saw divide the skull from within outwards Remove the director. Repeat the procedure until the desire area of bone is entirely detached. The Gigli wire saw is an exce lent instrument for use in the formation of trap-door opening through the skull.

(D) **Forceps.**—After perforating the skull as described the preceding paragraph, one may divide the bone between

perforations with bone-cutting forceps, *e. g.*, Keen's or DeVilbiss' (Fig. 5), and attain the same result as when the Gigli wire saw is employed.

(E) Electric Saws, etc.—Circular saws and drills driven by the surgical engine are used by some busy hospital surgeons as a means of quickly opening the cranium. They are rarely used in private practice, are useful but expensive luxuries, and any full description of their application would be out of place in a work such as this.

In all the methods of opening the cranial vault which have thus far been described the bone is removed over a greater or less area. Is it necessary to close this defect by anything more than replacement of the reflected scalp? When the scalp is replaced, in time the bone defect becomes filled with exceedingly hard and strong fibrous tissue sufficient to protect the cerebral contents from injury by ordinary violence. To prevent the formation of adhesions between the scalp and the cerebral contents many surgeons are in the habit of interposing between them divers smooth aseptic materials cut to such a shape that they will fit into the cranial defect. Of these materials, mention may be made of gold-foil, celluloid, thin rubber tissue, the membrane which lies between the shell and white of a hen's egg, etc. If the wound remains aseptic, these foreign bodies will lie in place indefinitely. Their use is particularly indicated after operations for epilepsy, but in the ordinary routine of cerebral surgery the author has distinct doubts as to their value.

Macewen fills up the osseous defect with the fragments of bone removed. These he arranges all over the exposed dura like a tesselated pavement. The larger fragments or buttons of bone he breaks into smaller pieces before implanting them. Excellent results have attended this procedure.

Instead of the fragments of bone removed, decalcified bone chips or particles of bone obtained from other patients or animals have been successfully implanted.

Osteoplastic measures have been devised to close defects in the skull with bone. König and others have formed flaps con-

sisting of the scalp and the outer table of the skull, and with these have covered the defect. Such measures are not often required.

Temporary Osteoplastic Opening of the Skull. Opening of the Skull by Means of a "Trap-door."—This method is of much use when the operation is exploratory or is undertaken for the removal of tumors or of the Gasserian ganglion.

Method I.—Make a U-shaped incision through the scalp around the area to be explored. Attend to hemostasis. With chisel and mallet divide the bone along the line of the skin-incision. It is often recommended that the bone-incision be made obliquely in such a manner that less of the inner table of the skull is removed than of the outer, so that when the flap of bone is replaced there will be no opportunity for it to become depressed. This precaution is entirely unnecessary. The flap outlined by the U-shaped incision of scalp and bone is reflected. To do this it is necessary and easy to fracture the bone transversely at the pedicle of the flap. Very large trap-door openings may be made; especially are such useful when the operation is for the exposure of a tumor.

Method II.—This method is exactly that described in the Hartley-Krause operation, page 49. Figures 4 and 23 show the appearance of a trap-door opening in the skull.

CLOSURE OF THE SCALP WOUND.

The scalp wound is closed by sutures. The author always prefers to introduce as few sutures as possible, because there is little tendency to retraction, and in this locality especially, any fluids which may be thrown out in the wound are very much better soaked up in the dressings than retained beneath the scalp. If few stitches are used, drainage is unnecessary even when thorough cleansing of the wound has been impossible, except in the presence of pus, or when a large cavity has been left after removal of tumor, etc. Drainage of the wound by a strip or wick of iodoform gauze has proved extremely unsatisfactory to the author; the gauze has almost always acted as a plug instead of a drain.

Of course, where more extensive drainage or packing is indicated, gauze properly introduced acts ideally. In suitable cases drainage-tubes of rubber, glass, or decalcified bone (chromicized) are to be employed.

After closing the wound apply the usual dressings. These are most conveniently held in place by a starch bandage.

HEMORRHAGE FROM THE MIDDLE MENINGEAL VESSELS.

The middle meningeal artery enters the cranium through the foramen spinosum, usually accompanied by two veins. It divides into an anterior and a posterior branch, which ramify in all directions over the dura. Meningeal hemorrhage is usually accompanied by fracture of the skull, but as it sometimes is caused by violence which does not injure the bone, and even by *contrecoup*, the operative treatment of the latter class of cases must be considered separately.

I. When focal symptoms permit the determination of the site of the bleeding, the indications for treatment are exceedingly simple. Trephine the skull at the site of the hemorrhage. A tough, dark-colored clot will be found. This must be removed with forceps, probe, spoon, and stream of hot water. Probably the trephine opening will require enlargement; possibly, a second opening may require to be made, as extradural clots are frequently very extensive. If active bleeding continues, search for its source by enlarging the trephine opening with forceps or making another opening as may be required. Ligate the vessel. Examine the dura carefully for signs of injury. If that structure is torn, cleanse the wound from blood-clots and close it with fine sutures. For suturing the author prefers fine silk or celluloid hemp to catgut, merely because the former are so thin that they can be readily threaded on very small needles. If the dura be found distended and discolored, or pulsation is absent showing that subdural hemorrhage is probably present, carefully incise

that membrane, remove blood-clot, stop bleeding, and close the dural wound. After the removal of extradural clots the dura soon becomes pushed up against the skull in its normal position, and the external wound may be closed without drainage.

II. In the absence of distinct focal symptoms the trephine must be applied somewhere along the course of the artery so that further bleeding may be stopped and, what is of greater importance, an opportunity may be obtained to explore for and remove the blood-clot. Roswell Park writes: "Vogt and Beck have suggested trephining at a point one and a half inches above

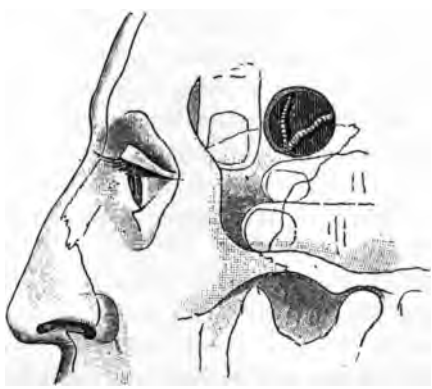


FIG. 6.—EXPOSURE OF MIDDLE MENINGEAL ARTERY.—(*Esmarch and Kowalzig.*)

the zygoma and the same distance behind the angle of the orbit. An inch trephine at this point is sure to expose the anterior branch of the middle meningeal artery. Nevertheless, the removal of the clot which causes the compression is much more important than merely finding the artery. Krönlein has made the suggestion of trephining twice, if necessary, in those cases in which the chance of finding the clot is good. He divides these hematomata generally into three classes: (1) fronto-temporal (2) temporo-parietal; (3) parieto-occipital. He suggests trephining over the artery first, and then, if no hematoma be found and the indications still point to meningeal hemorrhage, to tre

phine again just below the parietal eminence, because an opening in this position would expose either of the latter classes of blood tumors."

Figures 6 and 7 are self-explanatory.

Steiner has made a careful study of the surgical anatomy of the middle meningeal artery, and as a result has worked out the following method of reaching the vessel.

(A) (1) Draw a line from the middle of the root of the nose to apex of the mastoid process. (2) From the root of the nose

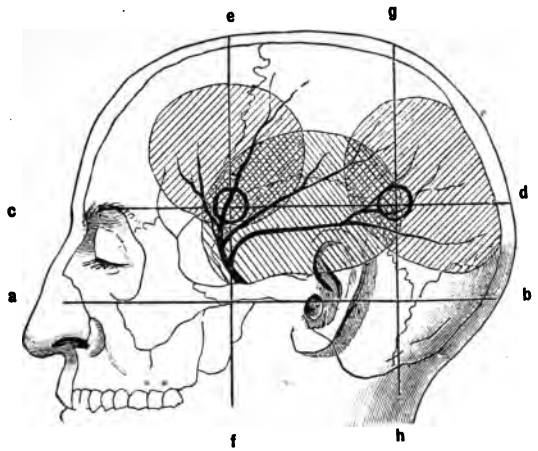


FIG. 7.—EXPOSURE OF MIDDLE MENINGEAL ARTERY.

a b. Base line from lower margin orbit through external auditory meatus. c, d. Parallel to a b, from upper margin orbit, backwards. e, f. Perpendicular to a b, and about 1½ inches posterior to external angular process. g, h. Perpendicular to a b, and immediately posterior to mastoid.—(*Esmarch and Kowalzig.*)

draw a line backwards parallel to a line drawn from the lower margin of the orbit through the middle of the external auditory meatus. (3) Bisect the first line by one drawn at right angles to it.

Where the third or vertical line crosses the second (*i. e.*, that parallel to the base line of the skull) is the point to trephine when searching for the anterior branch of the artery.

(B) To reach the posterior branch of the middle meningeal artery, trephine at the point where a line drawn directly backwards

from the root of the nose is crossed by a line drawn at right angles to it from the apex of the mastoid process.

OPERATING FOR FRACTURES OF THE CRANIAL VAULT.

In cases of compound or open fracture, the wound in the scalp may be enlarged so as to expose the skull, or, if more convenient, the scalp may be reflected by the usual U-shaped incision, as is done in simple fractures.

1. **Depressed Fracture.**—The principle to be followed is to elevate the depressed bone, remove all dirt, remove all sharp spicules, stop bleeding, and leave everything in the best possible condition for healing.

If beside the depression there is a sufficiently large hole in the skull, the depressed bone may be elevated or removed by means of periosteal elevators, necrosis forceps, or rongeurs. It is imperative, especially in compound fractures, to make an opening in the skull large enough to demonstrate the absence of dirt and hemorrhage. Failure to attend to this may be disastrous; the extra work involved in doing it does no harm. If no opening of sufficient size exists in the skull beside the depression, it is necessary to make one. This is usually done with the trephine. Apply the centre pin of the trephine to the solid skull beside the depression. Part of the cutting-edge of the instrument overlaps the fracture, but most of it lies on the unfractured bone. Remove a button of bone. In operating do not exert any pressure on the fractured fragments of bone lest injury to the cranial contents result. Remove or elevate the depressed bone. Remove blood-clot and foreign material. Stop bleeding. If desired the fragments of bone may be cleansed and returned if cor ditions are favorable. If the dura mater is torn, it must b cleansed and sutured. In severe injuries the brain itself is ofte much lacerated. The cerebral wound must be cleaned by gent' irrigation with hot water and loose fragments of brain remove Bleeding must be stopped by ligature, application of hot wa'

or packing with gauze. The divided dura must be sutured leaving an opening for drainage or for the gauze packing, and the external wound partially closed. When the dura is destroyed to an extent that its closure becomes impossible, it is wise to cover it with some smooth aseptic material, such as gold-foil, rubber tissue, or the like, unless drainage is necessary. When a drain is required, the part of the brain bereft of dura must be left largely to itself. In one case of the writer's where there was much destruction of brain and dura and the wound was infected the patient recovered perfectly in spite of the appearance of a hernia cerebri. The patient was seen several years after the accident and enjoyed perfect health.

2. **Fissured Fractures.**—When the fracture consists of a fissure involving *both tables* of the skull, the dangers to be combated are: (*a*) In compound fractures, dirt. (*b*) Intracranial hemorrhage. (*c*) Separation of spicules from the internal table and injury to the brain from them.

These dangers are met as follows: In compound fracture, that portion of the fissure near the scalp wound must be treated on the lines laid down for depressed fracture, and the rest of the fissure treated as if the fracture was of the simple variety. In simple fracture the fissure should be exposed, and with a small trephine, rongeurs, or chisel the skull removed at various points along the line of fissure sufficiently to permit the surgeon to satisfy himself as to the absence of hemorrhage or of the penetration of the brain by spicules of bone.

When the fissure does not involve the inner table of the skull, as demonstrated by probing with the blunt end of a needle, it is to be left undisturbed, unless in the neighborhood of a wound of the scalp. When exposed to dirt, as is always the case in compound fractures, the fissure should be cleaned by shaving its edges with a sharp chisel. Fissured fractures are usually met with radiating from other fractures of the cranial vault.

All fractures of the cranial vault ought to be subjected to exploratory operation whether they are depressed or not.

REMOVAL OF TUMORS FROM THE BRAIN.

Description of the methods of diagnosing and locating tumors of the brain would be out of place in this work. The diagram (Fig. 8) here presented is merely meant to act as a graphic reminder of the generally accepted position of some of the chief centres. Sherrington and Grünbaum find that in monkeys all the motor centres are *anterior* to the fissure of Rolando. F. Krause ("Die Deutsche Klinik," viii, 961) has substantiated these findings in man. Fig. 9 represents, on the left hemisphere,

FIG. 8.

the results of Krause's investigations in twelve operations. J. C. DaCosta and others agree with Sherrington's views. It is necessary, however, to study the relations which the sulci and convolutions of the brain bear to certain landmarks on the skull, so that it may be possible to expose the brain at the desired spot.

The simplest and most easily remembered means of finding the fissure of Rolando is that devised by Bennet (Fig. 10). At right angles to the sagittal suture draw two parallel lines, the anterior of which (*c–d*) runs along the anterior margin of the external auditory meatus; the posterior (*e–f*) touches the posterior margin of the mastoid process. These two lines will be about

two inches apart. On the anterior line take a point (*g*) two inches above the external auditory meatus, and from it draw a line (*g–e*) upwards and backwards to the point where the posterior line meets the sagittal suture. This oblique line is about three and three-quarter inches in length and corresponds to the Rolandic fissure.

The simplest means to find the point of bifurcation of the Sylvian fissure is the following (Esmarch): Draw a line one and one-half inches above and parallel to the zygoma. Draw a

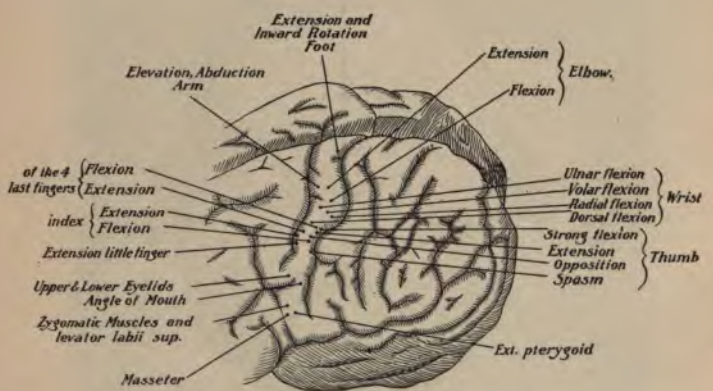


FIG. 9.

vertical line three-quarters of an inch posterior to the frontal process of the malar. These two lines cross at a point corresponding to the bifurcation of the Sylvian fissure. Vogt's method of finding the same spot is more easily remembered. The desired position is two finger-breadths above the zygoma and one thumb's width behind the frontal process of the malar (Fig. 6).

A more elaborate system for finding the cortical centres is that of Chiene ("Sajous' Annual," 1895) (Fig. 11): "Shave the head and find, in the median line of the skull, between the glabella (G) and the external occipital protuberance (O), the fol-

lowing points: The mid-point (M), the three-fourths point (T), and the seven-eighths point (S). Find also the external angular process (E) and the root of the zygoma (P) immediately above and in front of the external auditory meatus. Having found these five points, join EP, PS, and ET. Bisect EP and PS at N and R; also bisect AB at C and draw CD parallel to AM. The pentagon (ACBRPN) corresponds to the temporo-sphenoidal lobe, with the exception of its apex, which is a little in front of N.

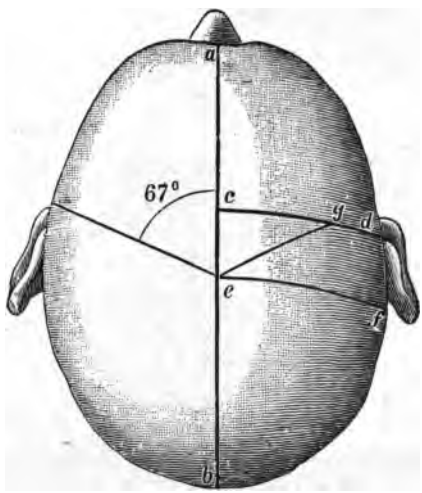


FIG. 10.—BENNET'S METHOD SHOWN ON THE RIGHT; THANE'S * ON THE LEFT.—(*Esmarch and Kowalzig.*)

MDCA corresponds to the Rolandic area containing the fissure of Rolando, the ascending frontal and the ascending parietal convolutions. A is over the anterior branch of the middle meningeal artery and the bifurcation of the Sylvian fissure; AC follow its horizontal limb. The lateral sinus at its highest point touche

* *Thane's Method.*—Draw the line *a–b* (Fig. 10) from the root of th nose to the external occipital protuberance. Take the point *e*, three-fourt' of an inch posterior to the middle point of *a–b*. A line drawn forwa and outwards from *e*, at an angle of 67 degrees to *a–b*, corresponds to fissure of Rolando.

the line PS at R. MA corresponds to the precentral sulcus, and, if it be trisected at K and L, these points will correspond to the origins of the superior and inferior frontal sulci. The supra-marginal convolution lies in the triangle HBC. The angular gyrus is at B."

Having determined by measurement, etc., the point at which removal of bone will expose the tumor, mark that point on the scalp, with iodine, nitrate of silver, the point of a cautery, or, what is far better, puncture the scalp with a small drill which

FIG. 11.

at the same time marks the outer table of the skull. If it seems proper, any desired areas of the skull may be mapped out by a series of drill marks.

Step 1.—Reflect the scalp and open the skull as already described. Generally one of the osteoplastic or trap-door openings is best. If the patient is weak or if there has been much loss of blood and shock sustained during this step in the operation, attend to hemostasis, apply dressings, and defer further proceedings for a few days. If the tumor cannot be removed, the

mere opening of the skull often relieves distressing symptoms, *e. g.*, agonizing headache.

Step 2.—Examine the exposed cranial contents both by inspection and palpation. In cases of tumor and blood-clot it is usual to notice an absence of cerebral pulsation and the dura often bulges into the trephine opening. By palpation tumors have been correctly located at a depth of one inch from the surface. Fig. 12 shows the appearance of a subcortical gliosarcoma in the arm centre, before and after incision of the meninges. Having recognized and determined the superficial boundaries of the growth, reflect the dura mater as a U-shaped flap. If the dura is involved in the growth, part of it must be sacrificed. When encapsulated, the tumor itself is removed by careful dissection with blunt instruments; a plain silver teaspoon is very useful for this purpose. Infiltrating tumors are unsuited for operation. Hemorrhage is arrested by gentle ligation of vessels when this is possible; by the application of gauze pads wrung out of hot water and by packing with iodoform gauze. The cavity left in the brain may require drainage by means of gauze, but the brain soon expands and fills up the space. After the active operation is completed close the wound in the dura and scalp, leaving, of course, an opening for the emergence of the gauze. If the skull has been opened by the trap-door method, enough bone must be removed from the flap to permit of proper drainage. When a portion of the dura mater has been excised, it is well to protect the brain by the application of a layer of rubber tissue or celluloid. This measure is only feasible if drainage is not required. If the tumor is cystic, drainage of the cyst is often recommended as sufficient, but in the author's experience this has proved futile, and he has been compelled to operate again and remove the cyst-walls.

Hemorrhage and shock are not the only dangers to be feared in cranial operations. It is well known that when the ventricles have been opened a dangerous condition of hyperpyrexia may develop. (Bergmann, de Verco, Parry Davenport: quoted by A. Broca, "Precis de Chirurgie Cerébrale," p. 323.) Sir Victor

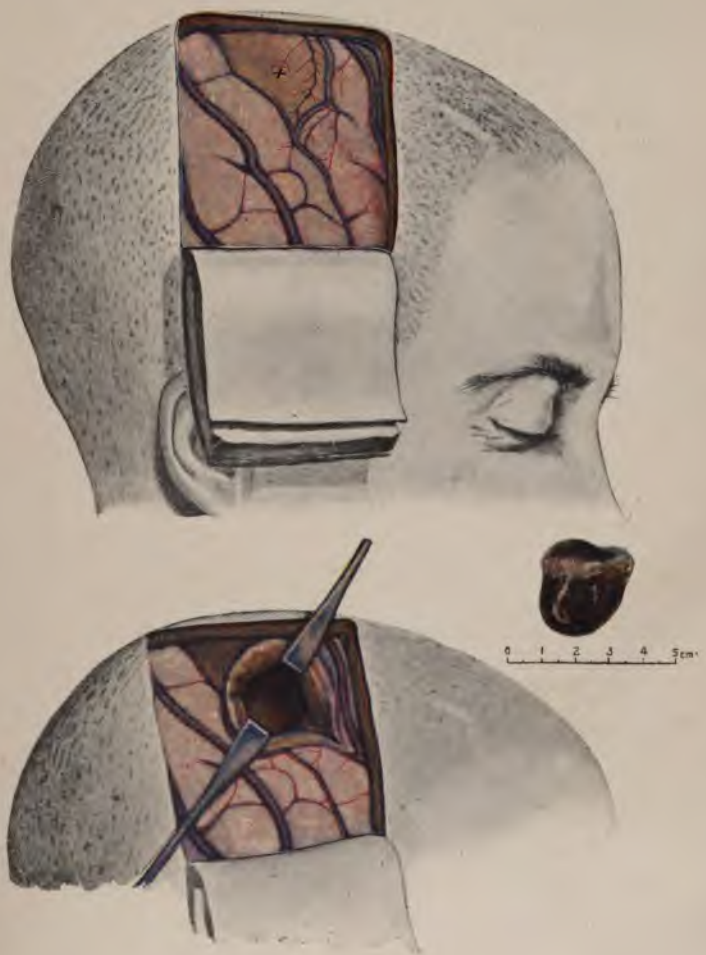


FIG. 12.
(*Krause—Die Deutsche Klinik.*)

Horsley is of the opinion that a thermo-taxic centre exists in the cortex and that when this centre is injured a condition of hyperpyrexia prevails independently of any injury to the ventricles. One case seen by the author, in which the skull was opened with chisel and mallet but the dura was undisturbed, died in a state of marked hyperpyrexia before sufficient time had elapsed for septic changes to have developed. Another case reported to the author by H. E. Pearse supports Horsley's contention. This case was one of depressed fracture. At the operation a rubber drainage-tube was inserted. Immediately the temperature rose to a high degree. The dressings were removed and the drain was found to have slipped between the skull and brain. On removal of the drain the temperature returned to normal and the patient made an uninterrupted recovery.

OPERATIONS FOR INFECTIVE DISEASE OF THE MIDDLE EAR AND CRANIAL CONTENTS.

Cerebral abscess is almost always the result of chronic otitis media. Proper treatment of the cerebral abscess requires removal of the original focus of disease. In the following pages the author makes free use of Macewen's classical work on the "Pyogenic Infective Diseases of the Brain and Spinal Cord." The reader is advised to carefully study the above book before attempting any operation for cerebral abscess. The present chapter is only written in the hope of aiding some practitioner who is forced to operate without the advantage of such study.

Suppurative disease of the middle ear unrelieved by treatment administered through the external meatus is always complicated by disease of the mastoid. The chief indications demanding operation on the mastoid cells are:

1. Repeated inflammations of the mastoid antrum and cells with swelling over or fistulæ leading into the bone.

2. Acute inflammation with retention of pus in the antrum or cells.

3. The occurrence of initial symptoms of intracranial involvement associated with chronic purulent otorrhœa.

4. Persistent chronic otorrhœa, not principally due to the condition of the tympanum or Eustachian tube, and which is considered by the aurist otherwise incurable, even although there are no clear indications of mastoid involvement.

5. If the discharge contain virulent organisms, if it be highly offensive, mixed with osseous débris or cholesteatomatous masses, operation is indicated, as most serious intracranial mischief is often present without marked mastoid swelling.

The Operation.—I. Cleanse the external and middle ear as thoroughly as possible. Shave the scalp above and behind the mastoid. Cleanse the skin.

Step 1.—Place the patient on his side with the affected mastoid uppermost. Have the parts well lighted. Pull forward the external ear. Palpate the mastoid and the posterior root of the zygoma. Make a perpendicular cut about one-quarter inch behind the posterior border of the external bony meatus from the posterior root of the zygoma to a point about one-third of an inch from the tip of the mastoid. The knife penetrates to the bone. With the elevator separate the periosteum and soft structures from the bone in front of the cut and thus fully expose the posterior aspect of the external auditory meatus. Attend to hemostasis. Hold the reflected tissues and auricle forward with a sharp retractor.

Step 2.—Observe the limits of the suprameatal triangle, viz., the posterior root of the zygoma above, the upper and posterior segment of the bony external meatus below, and an imaginary vertical line (EF, Fig. 13) extending from the most posterior portion of the external osseous meatus to the zygomatic root, behind. This vertical imaginary line is the base of the triangle. Observe the degree of obliquity of the posterior wall of the external auditory meatus as it leads inwards and forwards to the middle ear. By the aid of a probe observe the depth of the inner wall of the tympanic cavity from the level of the skull.

The best instrument for use in penetrating the bone is a bur

rapidly rotated by a surgical engine. Apply the bur to the bone at a point inside and beside the base of the suprameatal triangle. Penetrate the outer shell of hard bone. In some cases the whole mastoid is thickened and sclerosed by disease. With the bur, slowly and cautiously advance through the bone in a direction inwards and a little forwards, parallel to the posterior wall of the external auditory meatus. Do *not* use the bur as if it was a drill, making a uniform cylindrical perforation the same size as the

FIG. 13.—C, F, E (×). SUPRAMEATAL OR MACEWEN'S TRIANGLE.
A B. Upper two-thirds of this line overlies the sigmoid sinus. C, D. Overlies sigmoid sinus from knee to commencement.

instrument; this would be dangerous and nearly useless. Use it to make a hole in the mastoid very much larger than the instrument—large enough to permit of the continuance of the work under the guidance of the eye as well as touch. The external opening may safely be made the whole size of the suprameatal triangle. Whenever a dark spot is seen on the cut surface of bone, examine it at once with a fine probe or searcher (a dental probe is good). The dark spot is probably an opening into one

of the mastoid cells or even the antrum; if the latter, the probe will find a large cavity communicating with the middle ear. The depth of the antrum from the surface varies from one-eighth to three-quarters of an inch. A small opening having been made in the antrum and its cavity explored with a probe, bur away all its external wall, remove all pus, granulation tissue, or other disease products.

II. Observe the position of the opening between the antrum and the middle ear; the position of the facial nerve traversing the inner half of the floor of the antral passage obliquely from without inwards, as it passes into the inner wall and roof of the tympanum above the foramen ovale. The nerve route is often indicated by a cylindrical ridge of bone smoother and denser than that in the neighborhood. If the position of the nerve is not positively made out, have an assistant observe the patient's face for the occurrence of twitchings if the nerve is endangered in the subsequent proceedings. In observing the condition of the tissues deep down in the wound light should be thrown in, either by means of a head mirror or of an electric lamp (with reflector) held by an *aid*. Examine the roof of the antrum for evidences of bone disease. If buds of granulation tissue sprout from the roof, examine them; they may come from inside the skull and show the presence and location of intracranial involvement.

Step 3.—Examine the mastoid cells opened during exposure of the antrum; if they are diseased, as evidenced by the presence of granulation tissue, pus, etc., destroy their walls with the bur, so that instead of numerous, irregular, small cells, one large cavity with smooth walls is formed. Remember the location of the sigmoid groove and sinus (Fig. 13). Because of the sinus it is wise to open the mastoid cells by working from the antrum downwards and backwards. Never attack an exposed cell before thoroughly exploring it with a probe. Remember that granulation tissue and other disease products may be continuous from the middle ear through the antrum, mastoid cells, sigmoid groove, and sinus to the cerebellum. If granulations

are found sprouting out from the sigmoid groove or other evidences show disease in that locality, do not yet attack it. Complete the thorough cleansing of the antrum and mastoid, bur away all partitions, and leave them as one cavity with smooth walls.

Step 4.—The middle ear is diseased and requires to be opened. Apply a small bur at the junction of its roof with the outer wall of the antral passage. Do *not* touch the floor or inner wall of the passage for fear of injury to the facial nerve or semicircular canal. Freely expose the tympanic attic and examine its roof in the same way as the roof of the antrum was examined. Examine the malleus and incus; if diseased, remove them. It is important to leave the stapes, if possible; but if diseased, it also must be removed. If the mastoid, antrum, and middle ear are the only seats of disease, the active operation is ended; the cavity is packed with iodoform and boracic acid (1:4) and with iodoform gauze. Closure of the wound is facilitated by removal of a portion of the posterior bony wall of the external auditory meatus. Dressings are applied.

Step 5.—If on examination of the roof of the antrum or tympanic cavity erosions of the bone exist and granulations sprout out from the cranial cavity, or if there are symptoms of intracranial involvement, active operation is continued. With the bur remove the eroded bone of the antral or tympanic roof in a direction outwards from the perforation. If pus and granulation tissue present, there is an extradural focus which must be carefully cleansed. Do *not* inject any fluids until the whole space between the dura and bone has been explored and the presence or absence of openings through the dura made certain. If there is no dural opening, gentle washing is safe, and the extradural space may be dressed with iodoform and boracic acid and iodoform gauze. If there is evidence of disease under the dura, clean the extradural space and freely open the dura.

Step 6.—Pus in the arachnoid or pia or on the surface of the brain must be gently washed away, and iodoform and boracic acid powder must be applied. If an abscess exist in the temporosphenoidal lobe, enlarge the opening through the roof of the

antrum and tympanic cavity, apply iodoform and boracic acid to the wound, and proceed to Step 7.

Step 7.—Extend the cut through the soft parts upwards and expose the skull above the ear. Open the skull with a small trephine whose centre pin is applied at a point three-fourths of an inch above the posterior root of the zygoma and in line with the posterior osseous wall of the external auditory meatus. Rub iodoform into the cut surface of the bone. Incise the dura. If necessary, make a crucial incision. Stop bleeding. If the abscess is large, the brain will probably bulge and fail to pulsate; if small, neither of these signs may be present. To explore for pus use a trocar and cannula or a sinus forceps. A hollow needle is liable to become plugged. Introduce the instrument inwards, downwards, and slightly forwards so as to impinge, if pushed far enough, against the cranial aspect of the roof of the tympanum. If a trocar and cannula are used, the trocar should be removed at every quarter inch of progress to see if pus escapes; if a sinus forceps, the blades should be slightly opened for the same purpose. After pus is found, remember that the abscess probably contains sloughs and shreds of tissue too large to escape through the cannula and which must be removed. Alongside the cannula introduce closed, narrow-bladed hemostatic or sinus forceps; open the blades gently and permit the sloughs to flow out between the blades. If the sloughs cannot escape by themselves, they may be assisted out by forceps or spoon; their removal is of prime importance. After removal of the sloughs replace the hemostatic forceps by a small cannula. Through the mastoid wound and the opening through the antral roof introduce into the abscess cavity a cannula at least one-half as large again as that already *in situ*. Be sure that the end of this tube is in the cavity. It is wise to let the two cannulæ come in contact. Gently introduce a stream of hot water or mild antiseptic solution through the smaller tube and see that it all escapes through the larger. Lest fluid should enter the Eustachian tube, fill the middle ear with the iodoform and boracic powder. In an acute abscess which has been thoroughly cleansed of infective

matter, a drainage-tube is of little value and may do harm. If there is doubt as to the thoroughness of the evacuation, introduce a decalcified bone drain so that its opening is just within the abscess. Stitch the drain to the skin. If the abscess cannot be properly drained, in the above manner, use a rubber or glass tube for from twenty-four to forty-eight hours. Treat the mastoid opening as already described (page 23). Close the temporal opening with or without drainage on ordinary surgical principles.

[If abscess of the temporo-sphenoidal lobe exist, without indication of disease requiring the mastoid to be opened, the operation is carried out practically as described in Step 7; but in washing out the abscess an escape for the fluid must be provided by means of a cannula, at least half as large again as that through which it enters. The two cannulæ lie side by side.]

Step 8.—It has already (Step 3) been shown that disease of the sigmoid groove may be discovered while the mastoid cells are being obliterated. Examination with the fine probe or searcher shows that buds of granulation tissue coming through osseous openings are continuous with the same tissue in the sigmoid groove. Apply the bur to the posterior wall of the antrum and with it remove the bone backwards for half an inch horizontally. In a majority of cases this will open the greater part of the diameter of the sigmoid groove sinus, after which it may be opened above and below that point as may be indicated. The anterior knee of the sinus is situated from one-eighth to a quarter of an inch behind the base line of the suprameatal triangle (Fig. 13). If it seems necessary to open the sigmoid sinus to remove septic blood-clot, fully one inch of the sinus ought to be exposed, vertically, by removal of bone. Remove any diseased tissue lying between the groove and the sinus. If, on examination by the eye and the probe, the disease is found to extend through the bone into the cerebellum, this disease route must be followed and cleansed and any cerebellar abscess attended to in the manner to be described. If there is septic sinus thrombosis, open the sinus and remove the filth within it. After cleansing the

sinus, introduce into it a quantity of iodoform and boracic acid powder, make the walls of the sinus collapse, gently pack the sigmoid groove with the same powder, and loosely pack the whole cavity with iodoform gauze. If during the operation hemorrhage take place from a non-thrombosed sinus, it may be stopped, if slight, by temporary pressure; if more severe, by separating the wall of the sinus from the bone and pushing the loosened wall inwards by means of iodoform gauze packing. In certain cases Horsley has found it valuable to doubly ligate and divide the internal jugular vein. This is intended to prevent dissemination of the infective material throughout the body.

Step 9.—In the preceding step it has been shown how extension of disease through the sigmoid sinus to the cerebellum may be discovered. If this is the case, the disease is followed and the bone between the sigmoid groove (outer aspect of the groove) and the cerebellum is removed by the bur. The membranes covering the cerebellum are treated in the same manner as were those covering the temporo-sphenoidal lobe. If a cerebellar abscess exist, enlargement of the osseous opening already made permits of its evacuation and treatment on the principles already described.

After-treatment.—If there is no evidence of petrous or internal ear disease, the wounds must be packed with iodoform gauze to compel healing to take place from the bottom. The whole cavity ultimately becomes a solid mass of scar tissue. In the presence of petrous or internal ear disease a seton of iodoform gauze must be passed from the middle ear, through the antrum out by the mastoid opening. This gauze seton is frequently renewed and its route kept clean, until epithelium from the mucous membrane and the skin has so covered the track that a permanent fistula is assured through which any discharge from the internal ear or petrous bone may escape.

After the dressings are applied put the patient to bed, and keep him there until the wounds are completely healed. A low liquid diet is recommended for a fortnight after cerebral abscesses have been evacuated. The only peculiarity of the after-treat-

ment is the necessity of a little extra insistence on quiet, and on the observance of the usual rules adopted after major surgical operations.

Abscesses in other localities of the brain, after being diagnosed and located, are operated upon on the same principles as have been described in the preceding pages.

OPENING THE MASTOID WITH THE CHISEL AND RONGEURS.

Undoubtedly the bur operated by a surgical engine is the most elegant instrument with which to open the mastoid antrum, and it possesses many advantages over the chisel; but comparatively few surgeons possess the necessary instruments nor are they convenient to carry to a patient's home when the patient cannot or will not enter a hospital. Most surgeons possess some dexterity in the use of the chisel, but are not educated to the bur, hence the chisel, and its relative, the rongeur forceps, are the instruments commonly used in the mastoid operation.

The operation often ends immediately after the mastoid antrum is opened. This is improper, as the antrum is only one of many mastoid spaces, any or all of which may be diseased. Whiting ("The Modern Mastoid Operation"), in his superbly illustrated book, shows how the "air-cells" may extend above and over the bony meatus, and unless these are obliterated, the suppurative process is sure to continue. The principle of the complete operation on the mastoid is the obliteration of *all* the mastoid cells and the removal of all disease wherever situated, as described in the preceding pages. The method of operating adopted by the author is much as follows:

Clean the ear as well as possible. Shave and clean the skin over and around the mastoid.

Step 1.—Make an incision parallel to the insertion of the auricle, and about one-fourth inch posterior to the external auditory meatus. The incision stretches from just above the root of the zygoma to a little below the tip of the mastoid. Ex-

pose the whole surface of the mastoid by reflecting the soft parts along with the periosteum. A second incision at right angles to the first may be necessary to insure exposure. Examine the bone for points of necrosis or for the escape of pus at the vascular orifices.

It is specially important to examine the mastoid vein at its outlet, which is usually near the posterior margin of the bone. The vein varies in size and may divide into several branches as it passes through the skull. As the vein communicates directly with the sigmoid sinus, when the latter is thrombosed the former is likely to be in the same state. Thrombosis of the mastoid vein is positive evidence of sinus thrombosis; apparent patency of the vein is of no significance. Pus oozing from the mastoid foramen signifies pus situated outside the dura in the cerebellar fossa, about the sigmoid groove.

Step 2.—Pull the external ear well forwards with a retractor. Observe the depth and direction of the external auditory canal. Beginning at the upper part of the supra-meatal triangle, shave off *thin* slices of bone downwards and forwards towards the tip of the mastoid, always hugging the posterior margin of the bony meatus. This shaving is to be done with a chisel or gouge about one-fourth inch in width, propelled by a mallet. The chisel must be held almost parallel to the surface of the bone, and must always be directed downwards and forwards.

The usual chisels and gouges supplied for mastoid work are short and have thin shanks and handles. Such may be safe and convenient in the hands of aurists, but to the general surgeon a chisel with a handle like a Macewen osteotome, or even a carpenter's tool, is much safer and more practical. It is well to have a number of chisels or gouges of different sizes.

After several exceedingly thin slices of bone have been removed, the diploë will be reached, unless there is much sclerosis.

With a narrow curette scrape away the superficial portion of the diploë. If pus or fluid appears, note its quantity, as this gives some index to the size of the cavity from which it comes; note also if the pus is thrown out in jets or pulsating fashion,

because such pulsation is communicated from the brain and is almost absolute proof that the disease has penetrated at least to the meninges. With a probe gently explore the pus-cavity and enlarge the opening with curette, gouge, or rongeur, as may be convenient. *Never* endeavor to clean out a pus-cavity in the mastoid with the curette through a narrow external opening—it is too dangerous. If no pus or fluid appears, deepen the groove already cut in the bone to the extent of one-third of an inch. If the sigmoid sinus is abnormally far forwards, it ought now to be visible as "a soft, bluish-looking structure, very fluctuant to palpation and perhaps pulsating demonstrably, which upon gentle pressure of a probe yields readily but does not bleed" (Whiting). When the sinus is found in this abnormal position, the rest of the operation consists in exposing all the diseased cavities and evacuating all infective material, without injuring the sinus, unless that structure is also involved in the process. When the sinus is not abnormally placed, proceed with the removal of all the outer wall of the mastoid process.

Step 3.—With the chisel repeat the manœuvres by which the mastoid was originally opened, and so widen the existing opening that the blade of a rongeur can easily enter it and pass under the bone. With the rongeur carefully bite away the whole bony outer wall of the mastoid process. Never attack any part of the bone before making sure that the sigmoid sinus will not be injured.

Instead of widening the original opening in the bone with the chisel, the author usually inserts into it, partially, one blade of a heavy rongeur, the other blade of which rests against the mastoid farther back. By exerting a twisting force it is easy to use the posterior blade of the forceps as a fulcrum, and with the anterior blade (the blade engaged in the bony opening) to scrape off a thin layer of the cortical layer of bone. This method of using the rongeur is difficult to describe, easy and safe to practise, and aids materially in the operation. When the mastoid has once been opened to such an extent that the rongeur can be used efficiently, either as a biting or as a scraping instru-

ment, put the chisel and mallet aside as of no further use. If much sclerosis is present, this rule does not apply.

Step 4.—No attempt has been made, as yet, to find the antrum or systematically to obliterate the mastoid cells; the cortical bone has been removed at least to a large extent; the diploë has been but little disturbed. Remember that the antrum in 99 per cent. of cases (Macewen) lies in whole or in part within the supra-meatal triangle; that in the adult its depth beneath the cortical bone varies from one-eighth to three-fourths of an inch.

With a probe, once more observe the direction and depth of the bony meatus. With the curette, cautiously remove the cancellous bone from the supra-meatal triangle in a direction parallel to the posterior wall of the bony meatus. This will almost inevitably open the antrum. If the bone is much sclerosed, a small gouge must be used instead of the curette. Having opened the antrum, explore it thoroughly with a probe. With the curette, aided, if necessary, by rongeur forceps, remove all the external wall of the antrum. In the same manner remove *all* the mastoid air-spaces. Every step in the removal of bone must be preceded by careful examination of the tissues to be removed; remember particularly the normal site of the facial nerve (Fig. 14) and the normal, and particularly the abnormal, course of the sigmoid sinus.

The mastoid has now been converted into a comparatively shallow pit. Examine the walls of the pit carefully to see whether the disease process does or does not penetrate the cranial cavity. If the disease involves the sigmoid sinus or the meninges elsewhere, it must be attacked according to the principles already enunciated.

In *acute* mastoiditis, after the antrum, etc., have been cleaned out, the inflammation of the tympanum will promptly recede; hence it is unnecessary to use the curette in the tympanic cavity (Whiting). This is fortunate, as otherwise much damage to hearing might easily be inflicted. In cases of chronic mastoiditis and otitis the tympanum must be thoroughly opened and appropriately treated along the lines laid down on page 23 *et seq.*

Step 5.—With rongeur forceps and curette make smooth the floor and sides of the bony defect. Partially close the wound in the soft parts with sutures. Pack the remainder of the wound with iodoform gauze. It is comforting to the patient to have the gauze separated from the wound by a layer of perforated oiled silk or rubber tissue. After granulations have formed along the course of the pack they may be covered by Thiersch's

FIG. 14.—LEFT TEMPORAL BONE.

Antrum and most of the mastoid cells obliterated. 1. Semicircular canals. 2. Location of facial nerve in aqueduct of Fallopius, which has been opened. 3. Location of sigmoid sinus.

skin-grafts. This is usually two to three weeks after the operation.

It must be remembered that in children under three years of age the mastoid process is either absent, or its presence is merely indicated, while the antrum is to be sought rather higher than in the adult. In these young children the bone is so soft that the antrum may be opened with a curette.

OPERATIVE TREATMENT OF MENINGOCELE AND ENCEPHALOCELE.

Operation should not be undertaken in cases of the above tumors when there are serious concomitant malformations or when it is believed that portions of brain, necessary to life, are present in the growth. Horsley has suggested the application of the induced current to the tumor in order to diagnose if important cerebral tissue is involved. Some surgeons—*e. g.*, Berger—believe, and act on the belief, that any cerebral material present in a meningocele is neoplastic in nature and possesses no physiological function and may safely be disregarded. With the exceptions mentioned above Chipault considers all cases of meningocele suitable for operation. [Meningoceles of the cranial vault are alone referred to at present.]

The Operation.—Trace out two flaps of skin alone, over the tumor. The base of each flap corresponds to the pedicle of the tumor. Reflect the flaps. Expose the pedicle of the tumor at its exit from the skull. Transfix the pedicle, with a blunt needle, close to the skull, in one or more places, and apply two or more interlocked catgut ligatures. Tie the ligatures. Cut away the tumor distal to the ligatures. Replace the skin-flaps. Suture. Dress. Instead of ligating the pedicle as above described, it is better to open and explore the sac. If brain tissue is present, looks normal in character, and is reducible without giving rise to symptoms of compression, reduce such brain tissue, excise the rest of the tumor, and close the opening in the cerebral membranes with suture. If no brain tissue is present, excise the sac. If brain tissue is present but is either abnormal in appearance or irreducible, it must be excised. From the literature of the past nine years Chipault has collected fifty cases of meningocele subjected to operation with only nine deaths.

Meningoceles protruding through the base of the skull are rarely in situations accessible to the surgeon. In one case Fenger got access to the tumor by temporarily resecting the superior maxilla, and saved his patient. When it is possible to expose

basal meningocele the principles of operation are the same as those already described.

MICROCEPHALUS. IDIOCY.

Lane, Fuller, and Lannelongue advised removal of portions of the skull in cases of microcephalus, on the supposition that the early closure of the skull and consequent defective bone cavity impeded cerebral development. Variously shaped portions or strips of skull have been removed by many surgeons and the primary results seemed promising. The author in several cases was astounded to find, even on the day following operation, marked improvement in the condition of such patients. The improvements in speech and mentality were truly incredible, but in not one of the cases observed by him were these improvements retained, and he is forced to conclude that such operations are worthless. They will not be described here.

HYDROCEPHALUS.

For hydrocephalus many surgical procedures have been devised, but uniformly without particular success. The cranial cavity has been punctured and temporary or permanent drainage established; Morton's fluid has been injected; drainage of the spinal meninges has been established; pressure on the head has been attempted in various ways, but all to no purpose. Leonard Hill (quoted by Cheyne and Burghard) has shown that the amount of cerebrospinal fluid is regulated by absorption and exudation from the veins or lymphatics of the brain, more especially towards the base; and if any cause interferes with the normal regulation of this cerebrospinal fluid the result on the brain will be very serious. Meningitis interferes with this regulation, so that the fluid collects in the ventricles and causes hydrocephalus. The meningitis at fault is specially present at the base of the brain near the fourth ventricle, obstructing the exit of fluid from the ventricles, and hence its proper absorption. Based on the

above, G. A. Sutherland and one of the authors referred to attempted to establish the natural absorption by the following operation:

Reflect a flap of scalp and open the skull near and posterior to the anterior fontanelle (occasionally the lower angle of the fontanelle itself has been opened). Incise the dura. Take about 12 strands of thin catgut 2 to 3 inches in length and tie the ends together. Pass one end of this bunch of catgut downwards and backwards between the brain and the dura until about ¾ inch is left projecting from the opening in the dura. Seize the free end of this projecting portion in a forceps and push it through the brain into the lateral ventricle. Thus a catgut drain is made to stretch from the ventricle into the subdural space. Close the wound in the dura and the scalp. As a rule, the temperature runs up to 104° or 105° F., but falls again in the course of a week or ten days. The skull soon diminishes in size to a very marked degree.

The results have been better in congenital than in acquired hydrocephalus; in the latter it has been extremely difficult to keep up a channel of communication between the ventricles and the subdural space, and it has been suggested to use a more resistant form of drain. In spite of the success attained, the patients have generally succumbed, after a few months, to progressive meningitis. The operation is well worth trial.

OPERATIONS IN CASES OF EPILEPSY.

I. Idiopathic Epilepsy.—The name idiopathic epilepsy is used as a cloak for ignorance and to denominate the non-focal forms of the disease. A great variety of operations have been performed for the cure of idiopathic epilepsy, and the results have been good, bad, and indifferent, bad results being, however, the rule. The fact that many operations, some apparently affecting regions entirely unconnected directly with the head, have been followed by symptomatic cure of the disease led White to speak of "operations *per se*" being occasionally curative.

Undoubtedly it is good practice to correct possible sources of irritation in epileptics, such as tight foreskins, decayed teeth, errors in refraction, etc. When there is a clear history of trauma to the cranial vault and scars exist on the scalp, such scars should be excised, and if the skull shows evidence of old fracture it should be opened and any adhesions underlying it ought to be excised or any other local and possibly causal lesion corrected. Although all such operations are perfectly justifiable under proper conditions, yet the surgeon must not be too sanguine as to results. Almost any operation is frequently followed by a temporary cessation of epileptic seizures, but recurrence is the almost invariable rule. Jonnesco's method of sympathectomy (see page 156) cannot yet be considered of proved value.

II. Focal or Jacksonian Epilepsy.—In focal epilepsy the irritation seems to originate in some particular point on the surface of the brain and to radiate to other parts. The parts affected are those which have been mapped out in the study of cerebral localization. The causes of this condition are numerous. Depressed fracture, osteophytic growths, neoplasms, localized meningitis causing adhesions, hemorrhage, abscess, etc., are all efficient causes and ought to be removed or corrected. If no macroscopic lesion can be found when the skull is opened and the brain exposed, the precise area from which the attacks radiate may be defined by means of stimulation by weak electrical currents. The grey matter of this area, plus the pia mater covering it, may be excised. Of course, excision of an area of cortex means paralysis of the regions controlled by this area, but the paralysis seldom remains permanent. Immediately after the operation there is often a very temporary paralysis of parts supplied by neighboring centres. A few good results have followed cortical excision, but the rule is that epilepsy recurs when healing takes place. If a scar is removed from the brain, another scar is necessarily formed in the process of repair. Covering a cerebral wound with celluloid, gold-foil, or rubber tissue prevents adhesion between the brain, meninges, and scalp or skull, and is a useful precaution.

HEMORRHAGIC PACHYMENINGITIS.

Bullard and John C. Munro have made strong pleas for the consideration of hemorrhagic pachymeningitis as a surgical condition demanding operation. The disease, when not found in infants or the insane, is one belonging to the later years of life. Alcoholism, syphilis, acute and wasting diseases, as well as trauma, seem to have some causal relation to the disease. The symptoms are those of diffuse subdural hemorrhage, coming on slowly, producing mental irritation, spasm, paralysis, the sequences being more or less irregular. The cranial nerves are not liable to be affected. Without relief by operation the prognosis is practically hopeless; with operation, it is still very poor but better than without. One of Munro's cases recovered; it was that of an alcoholic sixty-two years of age, picked up on the streets unconscious. On admission to hospital he could not be roused. There was no bleeding from the mouth, nose, or ears. Temperature was normal, pulse 80; right knee-jerk absent; no rigidity; hematoma in right parietal region. Trephined on right side; no pulsation of dura, which was bulging and dark blue. Subdural clot covering the whole hemisphere removed. Trephined on left side; a diffuse, thin clot was found and removed. Towards the close of the operation consciousness returned. The result was complete recovery. In another case failure to trephine on both sides led to death, though immediate improvement followed the operation.

CHAPTER II.

FRONTAL SINUS.

Operation on the frontal sinus is indicated in empyema of that cavity. Frontal empyema is usually a concomitant of some form of chronic rhinitis. Either as a preliminary or complementary step in the operation it is wise to remove the anterior portion of the middle turbinated bone in order to simplify drainage.

The Operation.—Shave the eyebrow. Clean the field of operation. Protect the eyes with aseptic pads.

Step 1.—From the root of the nose make a curved incision outwards, parallel to and one-eighth inch above the upper margin of the orbit. The incision extends to a point just external to the supraorbital notch and penetrates to the bone. With the periosteal elevator separate the soft parts from the bone until the outer wall of the sinus is exposed.

Step 2.—With a bur, small trephine, or gouge carefully remove the exposed wall of the sinus, immediately to the outer side of the middle line, above the root of the nose. Only a very small area of bone should be removed at this time, and care is necessary lest such an instrument as the chisel should suddenly penetrate the thin bone and injure the posterior or inferior walls of the cavity. As soon as the bone is penetrated, the mucosa lining the sinus pouts into the wound. Incise the mucosa. Gently explore the cavity with a probe and with gouge or forceps (guided by the probe) remove the anterior wall of the sinus. Some surgeons are careful *not* to remove any of the orbital margin lest an ugly deformity result; others carefully remove every particle of bone which might interfere with the soft parts being brought in absolute contact with the deep wall of the sinus, the aim being to obliterate the cavity. Obliteration of the cavity

is often necessary, but as it causes marked deformity one is wise to try less mutilating procedures first.

Step 3.—With a sharp spoon remove all granulation tissue from the sinus and from its opening into the nose. With a small sharp spoon cleanse every nook and cranny. Be careful not to injure the orbital plate. Pass the sharp spoon from the postero-internal angle of the sinus downwards into the nose. The instrument goes through some of the ethmoidal cells and creates a good passage for drainage.

Step 4.—Pass a rubber tube from the sinus into the nose. Some surgeons do not permit the upper end of the tube to emerge through the skin, but close the cutaneous wound entirely, trusting to nasal drainage alone, as in Barth's operation; most operators place the tube so that it emerges both through the skin and the nose. Through-and-through drainage is probably best to begin with. During the after-treatment, if it becomes necessary to withdraw the tube temporarily, it is well to fasten a thread to the tube, so that as the tube is withdrawn the thread may take its place and serve as a guide for the introduction of a clean drain. Close all excess of wound with sutures. Dress.

After-treatment.—Warn the patient not to blow his nose violently, otherwise emphysema will result. When nasal drainage alone is provided, leave the tube *in situ* as long as possible, because once removed it is very difficult to replace. When through-and-through drainage is provided, withdraw the drain gradually, through the nose, as suppuration lessens. When drainage fails to cure the disease, the sinus must be obliterated by the method indicated in Step 2.

Killian's operation is very radical and successful. (Freudenthal, "Jour. Am. Med. Assoc.," Feb. 11, 1905.)

Step 1.—Make an incision down to the bone the whole length of the eyebrow, just above the orbital margin. Continue the incision at its inner and down the middle of the nasal process of the superior maxilla.

Step 2.—Open and explore the sinus either above or below the orbital margin.

Step 3.—With chisel and mallet make a furrow through the bone immediately above and parallel to the margin of the orbit. Remove with forceps the whole anterior wall of the frontal sinus above the furrow.

Step 4.—Clean out the sinus and remove its mucous membrane.

Step 5.—Remove with forceps the whole (orbital) floor of the sinus, leaving the orbital margin intact for cosmetic reasons.

Step 6.—Resect the frontal process of the superior maxilla and the rest of the floor of the sinus.

FIG. 15.

Step 7.—Resect the anterior and middle ethmoidal cells and the respective parts of the middle turbinal. These structures are always affected.

Step 8.—Close the wound after providing for drainage by a rubber tube.

The extensive removal of the floor of the sinus and consequent opening of the orbit cannot be without danger. The inevitable entrance of pyogenic organisms into the non-resistant fatty tissues must often give rise to orbital abscess.

Barth's Operation.—A little to the side of the middle line at the root of the nose make a longitudinal incision one inch in length, down to the bone. With a chisel carry the above incision through the nasal process of the frontal bone and the nasal

bone. At the upper and lower angles of the wound, by means of a narrow chisel, make horizontal cuts outwards through the bone. The flap of bone thus formed is pried outwards (Fig. 15) like a trap-door with hinge placed externally. The upper part of the opening is filled with the mucous membrane of the frontal sinus. Cut through this bulging mucous membrane. Through the above opening diseased tissues may be inspected and removed, free drainage through the nose may be provided, and if necessary the opposite sinus may be opened and treated. When the operation is completed, the bone-flap is restored to place and the vertical skin-incision is sutured.

CHAPTER III.

TIC DOULOUREUX.

In severe cases of trigeminal neuralgia, after treatment by removal of sources of peripheral irritation and by medicine has failed, operation offers the only hope of amelioration or cure. Very many operations have been devised, but not all of them are useful. The earliest operations consisted in the subcutaneous or open division of the nerve-trunks as they left or entered their bony canals. The supraorbital nerve was divided as it emerged from the notch of the same name, the infraorbital at the infraorbital foramen, and the inferior maxillary as it entered the posterior dental canal. In certain cases such operations gave marked and occasionally permanent relief, but after simple division of a nerve repair can take place with great rapidity, so that the neuralgia usually recurs at an early date.

Thiersch, after exposing the nerves at their exit from their bony canals, seized them in strong forceps and by slow twisting and pulling forcibly extracted a varying amount of them from their canal. Recurrence after this procedure was neither so prompt nor so constant as after simple division. Undoubtedly the best method of operating upon the nerve-trunks is by the removal of as much of them as is possible.

NEURECTOMY OF THE FIRST DIVISION OF THE FIFTH NERVE.

The first or ophthalmic division of the fifth nerve enters the orbit through the sphenoidal fissure and divides into three branches —the frontal, lachrymal, and nasal. The frontal nerve, the only branch of surgical importance, divides into the supraorbital and

supratrochlear. The supraorbital leaves the orbit through a notch or foramen situated at the junction of the inner and middle thirds of the supraorbital margin. With it run the supraorbital artery and vein.

NEURECTOMY OF THE SUPRAORBITAL NERVE.

Locate the supraorbital notch or foramen. Make a horizontal incision through the skin, parallel to and a little below the eyebrow. Separate the fibres of the orbicularis muscle. Expose the nerve as it passes through the supraorbital notch. Divide the orbitotarsal ligament. With a flat retractor depress the orbital fat. Follow the nerve backwards from the supraorbital notch, separate it from its surroundings, divide it as far back as possible, and remove all of it in front of the point of section. Close the wound with sutures. Dress.

A good modification of the operation is the following: Expose the nerve at its exit; isolate it for a short distance; seize its undivided trunk with a narrow-bladed hemostat; rotate the hemostat so that the nerve becomes wound around the jaws of the forceps; reverse the direction of rotation. By repeating the manœuvres of rotation and working slowly and patiently almost the whole peripheral portion of the nerve and much of its central trunk can be extracted.

NEURECTOMY OF THE SUPRATROCHLEAR.

The supratrochlear nerve is generally divided in the preceding operation, but occasionally it is missed and demands special attention. Draw an imaginary line from the angle of the mouth through the inner canthus of the eye. At a point a little below where a continuation of the above line crosses the eyebrow make an incision through the skin parallel to the fibres of the orbicularis muscle. Find the trochlea, which acts as a pulley for the superior oblique muscle. Locate the posterior portion of the superior oblique muscle. The supratrochlear nerve and its

branch, the infratrochlear, lie upon the superior oblique muscle and may be separated from it by a strabismus hook and excised.

NEURECTOMY OF THE SECOND DIVISION OF THE FIFTH NERVE.

Anatomy.—The superior maxillary nerve "commences at the middle of the Gasserian ganglion, and, passing horizontally

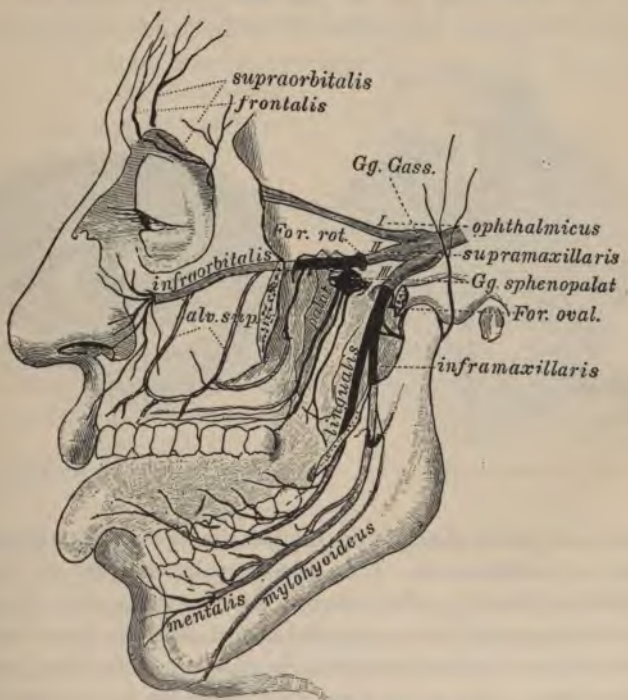


FIG. 16.—(*Esmarch and Kowalzig.*)

forwards, soon leaves the skull by the foramen rotundum of the sphenoid bone. The nerve then crosses the sphenomaxillary fossa, and, taking the name of *infraorbital*, enters the infraorbital

external angular process of the frontal bone, make an incision *backwards* and downwards to near the tragus. From the same starting-point make another incision downwards and *forwards* to the lower margin of the zygoma. Reflect downwards the triangular flap of skin and subcutaneous tissue thus outlined. With a finger saw, chisel, or Gigli wire saw divide the zygoma in front and behind. Rose recommends that before the zygoma is divided holes be bored on each side of the line of section so that everything may be ready for wiring the fragments in position on the completion of the active part of the operation. Separate the temporal fascia from the upper edge of the zygoma and turn the bone downwards. Retract the tendon of the temporal muscle backwards. The pterygo-maxillary fossa is exposed, with its fat and plexus of veins. If one now pushes the fat back with a blunt retractor, one at the same time keeps the venous plexus and internal maxillary artery out of the way. Demonstrate the posterior orbital fissure with a probe or strabismus hook and distinguish the superior maxillary nerve and its accompanying vessel (Fig. 20). The course of the nerve from its exit from the skull is downwards, forwards, and outwards. The artery runs inwards, forwards, and upwards.

FIG. 20.—(*Farabeuf.*)

Step 3.—Tie a ligature round the nerve for purposes of traction. Divide the central end of the nerve as close to the foramen rotundum as possible. By traction and torsion pull the peripheral end of the nerve out of its bony canal. By this operation the

whole trunk of the nerve is excised from the foramen rotundum to the cheek.

Step 4.—Attend to hemostasis. Replace the zygoma and fix it in position by wire or chromicized catgut sutures. Provide drainage. Close the skin wound. Dress.

NEURECTOMY OF THE THIRD DIVISION OF THE FIFTH.

The inferior maxillary or third division of the fifth nerve leaves the skull through the foramen ovale and divides into an anterior, motor, and a posterior division. The latter, almost entirely sensory, divides into the auriculo-temporal, the lingual, and the inferior dental. The lingual and the inferior dental are of surgical importance, and as they are generally both involved, if either of them is affected by neuralgia, their excision may be considered as part of one operation. (See Fig. 16.) Only one method of excising portions of the lingual and inferior dental nerves will be described, as it is so superior to any other method devised.

The Operation.—Shave the temple. Clean the side of the face and the external auditory meatus, and plug the latter passage with a little gauze.

Step 1.—Beginning about the middle of the zygoma cut backwards and slightly downwards to a point a little below the tragus, then continue the incision downwards along the posterior margin of the ascending ramus to the angle of the lower jaw. From this point cut forwards along the inferior edge of the horizontal ramus for about ¾ inch. The cut only involves the skin and subcutaneous tissue. Reflect the skin-flap, outlined as above, forwards. The flap, consisting of skin alone, leaves the branches of the facial nerve uninjured. Note carefully the position of Stenson's duct and of the anterior lobules of the parotid gland. Make a transverse incision parallel to and below Stenson's duct, directly down to the bone, at a point about ½ inch below the sigmoid notch. Any portions of the parotid gland which may be

in the way must be retracted backwards uninjured. With a periosteal elevator denude the outer surface of the ascending ramus of the jaw for a distance of one inch or more below the sigmoid notch.

Step 2.—Apply a ¾-inch trephine to the outer surface of the bone, the upper edge of the trephine being not more than ¼ inch below the edge of the sigmoid notch (D, Fig. 21). With the trephine perforate the ascending ramus and remove the button of bone. With rongeur forceps remove the bridge of bone (C, Fig. 21), separating the trephine hole from the sigmoid notch. The result of the above manœuvres is to deepen the sigmoid notch while the coronoid and articular processes are left in uninterrupted connection with the rest of the jaw.

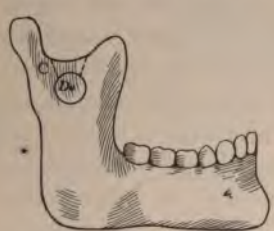


FIG. 21.

Step 3.—Retract the tendon of the temporal muscle forwards. With two pairs of dissecting forceps pick away any fat which may be in the way and demonstrate the external pterygoid muscle, which passes transversely across the wound from the outer surface of the external pterygoid plate to the articular process of the lower jaw. Note also the fibres of the internal pterygoid running downwards and backwards from the pterygoid fossa to the inner surface of the lower jaw near its angle. Retract upwards the lower fibres of the external pterygoid and thus expose both the lingual and inferior dental nerves, which, resting upon the internal pterygoid muscle, come out from under the external pterygoid and run downwards. The lingual nerve lies a little internal and anterior to the dental. Tie a ligature, for purposes of traction, round each nerve. Trace the nerves up to the foramen ovale and divide them there. Trace the nerves downwards and either divide them or by torsion and traction tear away as much of their peripheral portion as can be extracted. It is easy to remove more than an inch of the nerves.

Step 4.—Attend to hemostasis. Close the skin-wound. Drainage may or may not be used. Dress.

All the operations of neurectomy which have been described give at least temporary relief, but too frequently the *tic* returns after the lapse of a year or two. Occasionally the patient does not seem to get immediate relief from his pains. The author has in mind one case in which he removed portions of the inferior dental and lingual nerves. The patient suffered from neuralgia for one or two days after the operation. The pain was at once relieved on the removal of bloody fluid which had collected in the deep wound. Had the wound been efficiently drained, the temporary trouble might have been averted.

None of the operations of neurectomy for tic douloureux which have been described here are dangerous when performed by an experienced surgeon, but they are not a proper field for invasion by a tyro in surgery. In almost all the operations the wounds, while large, are so situated as to cause but little deformity from scar, especially if the subdermal suture is used in closing them.

HARTLEY-KRAUSE OPERATION.

It has been shown that tic douloureux very frequently recurs after even the most extensive excision of the nerve-trunks involved. It has also been shown (Keen and Spiller) that in the Gasserian ganglion very marked degeneration is present. When neurectomy fails to give permanently good results, it is most logical to attack the Gasserian ganglion. This has been done in many cases with excellent effect. The Gasserian ganglion may be exposed either from below or from above. The former method has been thoroughly studied by Rose, Andrews, and others. Their route entails temporary resection of the zygoma and the coronoid process, the use of the inferior maxillary nerve as a guide to the foramen ovale, exposure of the base of the skull beside that opening, the removal of a button of bone from the exposed portion of skull with a trephine, and lastly a rather haphazard removal of the ganglion when it is reached. Any one

who has had occasion to operate in the neighborhood of the foramen ovale can appreciate the difficulties of the operation. Hartley and Krause almost simultaneously devised a method of reaching the Gasserian ganglion by an intracranial route. Their operation is so much better than the others that it alone will be described here.

The Operation.—Shave at least one-half of the patient's head. Clean the head, face, and external auditory meatus. Pack the external auditory meatus with aseptic gauze.

Step 1.—As there are several methods of performing this step, they will be taken up seriatim.

Method A: Beginning on the zygoma immediately in front of the tragus, make an incision upwards, directly to the bone. Make the incision run a curved course (convexity upwards) and end on the zygoma at a point about 1½ inches in front of the starting-place. The curved incision outlines a flap 2½ inches in height, 2 inches wide at its broadest part, and having a pedicle 1½ inches wide. The flap is shaped somewhat like a uterus. Check the bleeding. With a chisel and mallet or a gouge, having a V-shaped cutting-edge, divide the skull along lines corresponding to the wound in the soft parts. When the skull has been completely divided, raise the bone and soft parts adherent to it (skin, temporal muscle, periosteum) and turn them downwards, breaking the bridge of bone opposite the pedicle. The soft parts act as a hinge. The line of fracture where the bone-flap is reflected is opposite the zygoma, and hence is at a higher level than the base of the skull. With rongeur forceps cut away the bone immediately below the opening in the skull, until the true floor of the middle fossa of the skull is reached. This removal of bone after the bone-flap has been reflected is a very important step in the operation.

Method B: Much time may be saved by using a circular saw or protected drill driven by an electric motor or surgical engine, instead of the chisel and mallet. Comparatively few surgeons possess such apparatus.

Method C: Krause suggests the following method in cases

where it is imperative to avoid loss of blood. Have an assistant exercise pressure on the temporal artery. With a knife make an incision directly to the bone corresponding to the upper margin of the flap to be reflected. Through this cut separate the soft parts from the bone, with a periosteal elevator, down to the level of the zygoma. Rapidly make the anterior and posterior incisions of the flap. Attend to hemostasis. By the above means hemorrhage from the soft parts is avoided. Open the skull with a trephine. Remove as much bone with rongeur forceps as is reflected or removed in Method A. This method has a very limited application and leaves marked deformity, as no bone is replaced.

FIG. 22.

Method D: Trace by an imaginary line on the temple the flap A, B, C, D, of similar shape and in the same position as that described in Method A. Join the points A and B (Fig. 22) by an incision, cutting directly to the bone. At the points A and B perforate the skull by means of a Doyen perforator or small trephine. With a dural separator separate the dura from the bone between the perforations. Pass a slightly curved grooved director between the dura and the bone from the opening A to the opening B. Along the grooved director pass a Gigli wire saw. The ends of the wire saw emerge at A and B. The loop of the wire lies against the inner surface of the skull between A and B. The cranial contents are protected by the director. Saw through the skull between A and B, cutting from within outwards. With a knife make the cuts A C and B D. Catch up all bleeding points in forceps as soon as they are observed. With narrow-bladed rongeur forceps (Dahlgren's, Keen's, etc.) divide the bone along the lines A C and B D. There is now a flap consisting of bone and superjacent soft structures which may be reflected downwards by breaking the bone along the line C D. The rest of Method D is identical with Method A.

Step 2.—In the preceding step the bone has been removed down to the more or less horizontal base of the skull. With the finger *quickly* separate the dura from the bone until the foramen spinosum and middle meningeal artery are reached. Krause finds that quick work with the finger is without danger and produces less venous bleeding than slow separation with a blunt

Fig. 23.—(*Krause.*)

raspatory. However done, there is much venous bleeding which is stanched by pressure with gauze. When the foramen spinosum is reached (Fig. 23), gently lift the brain, covered by dura mater, with a spatula, whose blade, about 1¼ inches wide, is bent at a right angle. The brain is retracted sufficiently to give a good view of the deep structures to be attacked. Isolate the

middle meningeal artery at the foramen spinosum, doubly ligate and divide it. Often the artery runs in a very deep groove or even in a canal in the skull and therefore becomes torn while the bone is being removed. Again, the vessel may be torn at its exit from the foramen spinosum. In such circumstances bleeding may be stopped by pushing into the foramen or canal a thin strip of gauze by means of a blunt-pointed instrument. The end of the gauze strip must of course be brought out of the wound to allow of subsequent removal. Instead of gauze, catgut or Horsley's wax may be used. After attending to the middle meningeal artery continue separating the dura from the bone in the direction of the ganglion. This is done with a blunt instrument or with small pledgets of gauze held in hemostats. Bleeding is free, hence from time to time it is necessary to pack a little gauze underneath the flat retractor and press the gauze against the bone with the retractor for a few seconds. A slight change in the position of the retractor often causes the bleeding from the dura to cease. The ganglion having been reached, note that its upper surface is often firmly adherent to the dura. Separate these adhesions by blunt dissection. If the dura is injured, cerebrospinal fluid escapes but no harm results. Demonstrate the second and third divisions of the fifth nerve and divide them with a tenotome at the foramen rotundum and ovale respectively. Do *not* try to demonstrate the first division; it is in too close union with the cavernous sinus. If bleeding accompanies division of the second and third divisions of the nerve, it is easily stopped by pressure or by boring a blunt instrument into their foramina. Seize the posterior portion of the Gasserian ganglion transversely in the jaws of a hemostat. [It is well to do this after the second and third divisions have been isolated but not divided. After the ganglion is fixed by the forceps the two divisions of the nerve may be divided at their foramina.] With the forceps make traction along the axis of the nerve. This extracts the ganglion, and with it a longer or shorter portion of its root.

J. Hutchinson, Jr., advocates division of the superior and inferior maxillary nerves and removal of the corresponding por-

tion of the ganglion, leaving intact the ophthalmic division and its portion of the ganglion (Fig. 24).

Step 3.—Replace the brain in position. Suture the temporal flap, consisting of bone and superjacent soft structures, in place. Provide drainage if necessary and apply dressings.

Step 4.—For several weeks after the operation danger threatens the eye of the side attacked, if for no other reason than that the eye, being rendered anesthetic, is subject to injury from dust, dressings, etc. Keen recommends keeping the eye clean by means of boracic-acid lotion, keeping the eyelid closed by one or two stitches, so placed that while the eye is closed the boracic lotion may still be applied. The stitches are removed from the

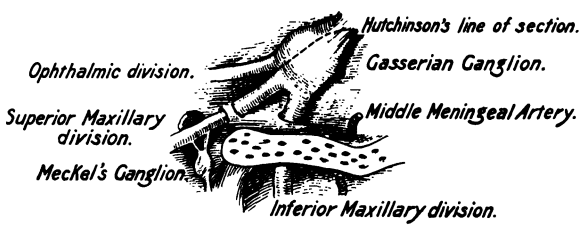


FIG. 24.—LEFT GASSERIAN GANGLION EXPOSED FROM THE SIDE.

eyelids after two or three days and the eye protected by a watch-glass shield held in place by adhesive plaster. These precautions seem entirely competent to prevent ocular trouble.

Occasionally when performing the Hartley-Krause operation free hemorrhage or the low condition of the patient demands that the operation be suspended. Under such circumstances the wound is packed with gauze, dressed, and the patient kept in bed for a few days, when the work may be resumed.

The Gasserian ganglion lies close to the cavernous sinus, and this structure has been wounded on more than one occasion, but the gush of blood has always been easily checked by gauze pressure. Fortunately the blood-pressure in the sinus is very low.

To gain a nearer approach and at the same time to avoid trouble from the middle meningeal artery Cushing exposes the

Gasserian ganglion by a route lower than Hartley-Krause and higher than Rose. The method is similar to that of Poirier, but less severe.

CUSHING'S OPERATION.

Step 1.—From a point one-half inch behind and slightly above the external angular process of the frontal bone make a curved incision down to the zygoma, immediately in front of the ear. The highest point reached by the incision is two inches above the zygoma. Reflect the skin downwards. Resect the zygoma subperiosteally. Make a curved incision, parallel to the above, through the temporal fascia and muscle. Reflect these downwards, exposing the lower part of the temporal fossa.

Step 2.—With chisel or gouge open the skull at the most prominent part of the exposed great wing of the sphenoid. With rongeurs enlarge the opening until it is about 1½ inches in diameter and extends down to and includes the ridge between the temporal and zygomatic fossæ. The middle meningeal artery lies on the dura, running obliquely across the opening in the skull, the lower part of which is on a level with the resected zygoma.

Step 3.—Lift the dura and the artery from the base of the skull until the firm attachment of the former at the foramen ovale is reached. Support the cerebral structures gently with a well-rounded, pliable spatula or retractor about one inch wide, which should be held by the surgeon himself. Using the inferior maxillary nerve as a guide, split the sheath of the ganglion and expose its upper surface.

Step 4.—With a blunt dissector isolate but do not yet divide the three divisions of the trigeminus. Isolate the ganglion and its sensory root. Grasp the ganglion just anterior to the root with a hemostat. Lift up the peripheral divisions on a hook and divide them. Evulse the root with forceps. During all this time venous bleeding may be controlled by temporary pressure with gauze. Cushing, Brewer, and others find that no benefit results from preliminary ligation of the external carotid artery,

as the most troublesome bleeding is venous. It is a needless step, therefore, as the middle meningeal can be avoided.

Step 5.—Put in place, when necessary, a cigarette or protective rubber drain. Close the wounds in the muscle and fascia, not forgetting the fascial wound made in resecting the zygoma. Close the skin-wound. The drain, if one has been used, may be removed in forty-eight hours.

Abbé, to avoid the dangers of hemorrhage, shock, and prolonged operation, has given up attempts to formally resect the Gasserian ganglion. He performs an intracranial neurotomy or preferably neurectomy, and then prevents reunion of the divided nerves by interposing a layer of thin rubber tissue, sterilized by immersion in corrosive sublimate solution, which is washed off with salt solution. To lessen hemorrhage from the middle meningeal artery Abbé ligates the external carotid just above the thyroid.

THE ABBÉ OPERATION.

"Ligate the external carotid; make a straight incision in the temporal fossa above the zygoma; split the temporal muscle, scraping it widely from the bone, and enter the skull by a small trephine opening, rapidly enlarged by rongeurs to one and one-half inches in diameter. Expose the second and third branches from the Gasserian ganglion to the foramina. Seize each at the foramen by a narrow clamp, cut it, and resect a half inch or tear it from the ganglion; push back the dura well beyond the foramina; arrest bleeding by a moment's pressure, and spread over the bone a piece of sterile rubber tissue, enough to more than cover both foramina, one inch wide by an inch and a half in length, which must be pressed upon the bone by a strip of gauze packed over it for a couple of minutes. When this is removed, the rubber tissue lies in close contact with the skull and the dura is allowed to settle down to its place upon it. The wound is then closed by a few fine catgut sutures and drained for a day at its lower angle." ("Trans. Am. Surg. Assoc.," 1903.)

G. R. Fowler has used Crile's plan of temporary occlusion of both common carotids and found it useful. In one case a tape passed round the carotid and secured by a clamp, pressed against the internal jugular vein and caused much venous oozing during the operation. Abbé's operation has given most excellent results, and seems in every way preferable to the infinitely more formidable excision of the ganglion.

When should one practise excision of the Gasserian ganglion? In cases of intolerable tic douloureux one should try the milder operations of neurectomy, as their death-rate is much lower than that of the major operation; they are, in fact, safe operations and good permanent results are sometimes obtained. Furthermore, the neurectomies give at least temporary relief, and so permit the strength of the patients to be built up. This is important, as the sufferers from tic douloureux are often much reduced from their long-continued agony. The Abbé operation being as successful as the Gasserian ganglion excision and not very much more dangerous than some of the extracranial neurectomies, ought, in many aggravated cases, to be given the preference over these.

CHAPTER IV.

EXCISION UPPER JAW.

Many incisions have been devised to expose the superior maxilla. Probably the best are those of Weber (A, B, C, D, Fig. 25) and Velpeau (V, P, Fig. 25).

Weber's Incision.—Beginning immediately below the inner angle of the eye, make the incision B, C, D, which skirts the ala of the nose and divides the upper lip in the middle line. From the point B (Fig. 25) make the curved incision (B, A, Fig. 25) which follows the lower margin of the orbit. Reflect outwards the flap outlined by the complete incision.

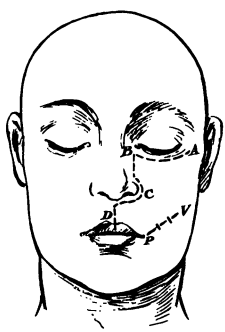


FIG. 25.

Velpeau's Incision.—This incision is very similar to that of Syme. Beginning at the angle of the mouth, make the incision P, V (Fig. 25), through the whole thickness of the cheek. The cut runs obliquely upwards and outwards from the angle of the mouth for such a distance as will permit of exposure of the superior maxilla by reflection of the cheek upwards and inwards. This incision is not so good as Weber's.

Separate the periosteum covering the floor of the orbit from the bone. Gently lift the orbital contents upwards with a flat retractor. With a bone forceps or Gigli saw divide the malar bone and with it part of the orbital floor at the point Z (Fig. 26). In the same manner divide the nasal and orbital processes of the superior maxilla at the point X (Fig. 26). Open the patient's mouth and with a knife make an incision through

the muco-periosteum of the hard palate, parallel and close to the middle line. Continue this incision forwards and then upwards through the muco-periosteum covering the alveolus to the nasal aperture. With bone forceps, Gigli or finger saw divide the hard palate and alveolus along the line of the muco-periosteal incision. With knife, or better with scissors, separate the soft palate from the hard palate on the side being excised.

FIG. 26.—EXCISION OF UPPER JAW.
X, Y, Z. Usual lines for division of bone. P, Q. Section may be made here instead of at Z, when disease is extensive.

Seize the superior maxilla with lion-jawed forceps and forcibly remove it with a twisting motion. Any undivided strands of tissue may be severed with scissors. The internal maxillary artery will generally be found bleeding vigorously in the depth of the wound. It should be seized with forceps and ligated. Oozing is stopped by pressure with ganze pads wrung out of very hot water. Pack the wound with iodoform gauze. Replace the

flap of soft structures over the packing and suture it in position.

The after-treatment consists in having the patient lie on the side operated upon or sit up in bed or a chair as early as possible. This is to avoid danger of pneumonia. The mouth must be kept clean. Closure of the wound usually takes place rapidly. When recovery has taken place, consult a good dentist with regard to the use of an artificial palate.

Keen notes that sarcoma of the upper jaw often extends through the infundibulum into the frontal sinus. This extension must be looked for and removed. Extend the incision C, B (Fig. 25) upwards to the nasal side of the inner canthus over the frontal sinus. Remove with a small rongeur the anterior wall of the infundibulum and of the frontal sinus; wipe away the tongue-shaped process of the sarcoma with a gauze pad.

W. J. Hearn, Matas, and others always ligate the external carotid before excising the jaw. The former surgeon finds in doing so that he always exposes some enlarged glands which require removal. Matas emphasizes the importance of ligating the external carotid high up, well above the bifurcation, otherwise there is danger from cerebral embolism.

A. H. Ferguson's operation, suitable in cases where the skin is not involved.

1. Place the patient with head hanging over a sand-bag.

2. Make an incision about one-half inch long over the nasal process of the superior maxilla; through this, with an osteotome, divide the bony process.

3. Repeat Step 2 over the junction of the superior maxilla and the malar and divide the bone.

4. Cut through the alveolar process and the hard palate. Save as much of the soft palate as possible.

5. With elevator or forceps evulse the jaw and pull it out through the mouth. Pack the cavity with iodoform gauze.

BARDENHEUER'S OPERATION FOR PARTIAL EXCISION OF THE UPPER JAW AND IMMEDIATE PLASTIC REPAIR.

By means of the incision A, B, C (Fig. 27) the flap C, E, D is reflected and the jaw and tumor exposed. By means of saw,

FIG. 27.—(*After Bardenheuer.*)

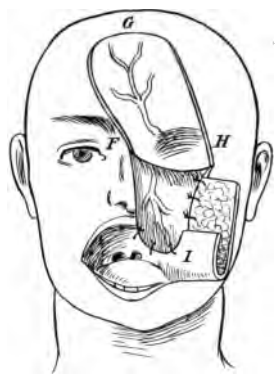


FIG. 28.—(*After Bardenheuer.*)

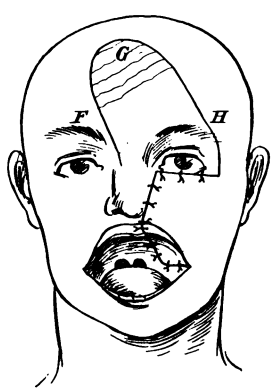


FIG. 29.—(*After Bardenheuer.*)

bone forceps, and scissors the jaw is partially excised, the object being to remove the tumor and with it a safe margin of healthy

bone. Bleeding is arrested by ligature, hot water, and sponge pressure. The incision F, G, H (Fig. 28) outlines a skin-flap (hairless) in the pedicle of which is a portion of the skin of the upper eyelid as well as the whole eyebrow. The flap is turned (epidermis inwards) into the position F, I, H, and there sutured. The flap C, E, D is now turned back into its old position and there sutured. Most of the wound F, G, H is covered by Thiersch's grafts. After the lapse of two weeks the pedicle of the flap F, H, I is divided and the eyelid and eyebrow contained

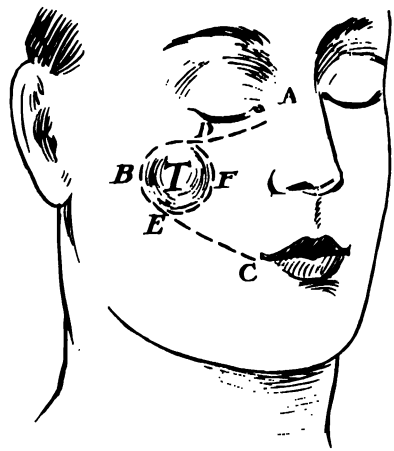


FIG. 30.

in it returned to their normal position. The wound left where the pedicle was divided must be trimmed and closed. The result is seen in Fig. 29.

EXCISION OF SUPERIOR MAXILLA WHERE THERE IS TUMOR INVOLVING BOTH THE BONE AND THE SKIN.

Make the incision A, B, C (Fig. 30). Isolate the tumor from the rest of the skin by the incision D, F, E, which joins A, B and B, C at the points D and E. Reflect the

flap A, D, E, C towards the opposite side of the body (Fig. 31). Reflect the skin at B towards the ear so as to expose the zygoma and the frontal process of the malar. Divide the bones as shown by the dotted lines in Fig. 31. Remove the tumor and superior maxilla as in the classical operation for excision of the upper jaw. Pack the wound with iodoform gauze. Replace the flaps and suture them in position.

EXTENSIVE EXCISION UPPER JAW.

The younger König in very extensive disease of the upper jaw necessitating removal of the floor and outer wall of the orbit recommends the following operation:

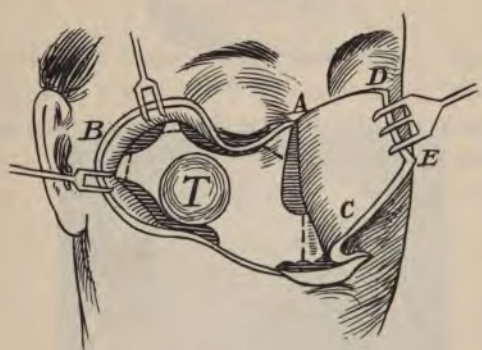


FIG. 31.

1. Ligate the external carotid between the origin of the superior thyroid and lingual arteries. This step is simple, harmless, and very useful.

2. Expose the bone by Velpeau's incision. Remove the disease.

3. Recognize and expose the temporal muscle in the outer part of the wound. At the level of the coronoid process and about 1½ fingerbreadths from its anterior margin split the muscle upwards and downwards. With a chisel divide the ascending ramus of the lower jaw along the line in which the muscle was split. The result of the above is to provide a flap, consist-

ing of temporal muscle and bone, attached above to the skull and free below (Fig. 32).

4. Turn this flap inwards and unite its free extremity to the remains of the frontal process, so that a firm floor is provided for the orbit and the eye is kept in place.

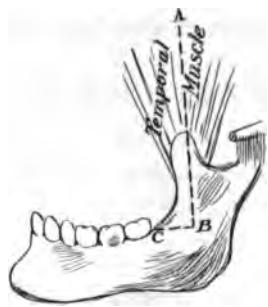


FIG. 32.

5. Complete the operation by closure of the skin-wound and packing with iodoform gauze.

FIG. 33.

RODENT ULCER.

As a type of operation for rodent ulcer an example may be taken where the disease involves the malar, the superior maxilla, and to a moderate extent the orbit.

1. Make an incision around the disease, and distant from it one-half inch (Fig. 33).

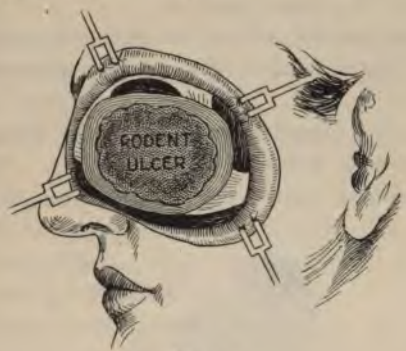


FIG. 34.

2. Leaving the diseased tissue undisturbed, reflect the soft parts all around it from the bones so as to lay bare to touch

FIG. 35.

the upper margin of the orbit, the external angular process of the frontal bone, the temporal process of the malar (Fig. 34), the

external anterior surface of the superior maxilla above the alveolar process, and the nasal bone on the affected side. As hemorrhage occurs, it must be arrested *at once*.

3. With bone forceps or chisel cut through the bones as shown in Fig. 35. Bone incision A (Fig. 35) penetrates the antrum of Highmore.

4. Separate the orbital contents from the roof of the orbit and divide the optic nerve.

It is now easy to remove the disease surrounded by a fairly

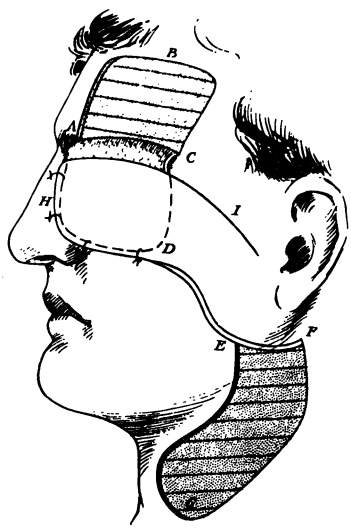


FIG. 36.

large zone of healthy tissue. The cavity is packed with iodoform gauze. After the lapse of about ten days endeavors may be made to lessen the deformity which has been produced. As the cavity is largely lined by mucous membrane, it is proper that an endeavor should be made to provide its new covering with an epidermal surface internally.

Type of Operation to Repair the Deformity.—On the *hairless* forehead make the incision A, B, C, Fig. 36, so as to

obtain a flap, A, C, D, of size and shape suitable to provide an epidermal outer and anterior wall to the cavity left by operation. The base (A, C) of the flap is a little above the orbit and ought to extend beyond the orbit on one side or the other so as to have plenty of nourishment. The flap is now turned down so that its epidermal surface faces inwards, its raw surface outwards. The edges of the flap are stitched with catgut in the position A, C, D (Fig. 36). From the neck the flap E, F, G is dissected up and sutured in the position F, E, H, I. The raw surfaces A, B, C and E, F, G are lessened in size by sliding their edges centripetally and there suturing them. Any parts not covered by skin are now grafted by Thiersch's method.

After the lapse of two weeks, if everything has gone well, the pedicles of the flaps A, D, C and H, I, E are divided and their remnants turned back into their old positions. A certain amount of trimming and suturing must be done at the margins of the now repaired deformity.

Note.—In the original operation when the bone incisions are being made it is wise to divide the nasal bones last, so as to avoid the entrance of blood into the nose. The complete dissection of the soft parts before attacking the bones ensures that most of the bleeding will have been attended to before any of the facial cavities have been opened. Should the patient's strength warrant, the reparative work might be done at the same sitting, but the disease generally affects the old and debilitated.

CHAPTER V.

LOWER JAW. RESECTION.

I. RESECTION OF THE ALVEOLAR PROCESS.

Incise the muco-periosteum around the portion of bone to be excised. If the portion to be excised is small, its removal may be effected with rongeur forceps or with the chisel and mallet. In using the chisel the surgeon should hold the instrument in one hand, support the jaw with the other, and let his assistant manipulate the mallet. When the excision is to be more extensive, one may with a finger saw make a vertical incision through the alveolar process in front of, and another behind, the portion to be removed, and join the lower ends of the vertical incisions by a horizontal one cut with a chisel or a saw operated by a surgical engine.

II. PARTIAL RESECTION OF THE HORIZONTAL RAMUS.

Make an incision through the skin down to the bone along the inferior edge of the jaw. Separate the soft parts from the inner and outer surfaces of the jaw. If the operation is done for necrosis, preserve the periosteum; if for tumor, sacrifice it. Divide the jaw by vertical incisions made with the Gigli wire or the finger saw, in front of and behind the disease. If teeth are present at the lines of vertical incision, they must be removed before the saw is applied. Remove the segment of bone between the vertical cuts. Whenever the nature and extent of the disease permit, it is important to leave the lower edge of the jaw *in situ* (X, Y, Fig. 37), as then the continuity of the maxilla is maintained. To accomplish this, the vertical bone incisions do not

completely divide the jaw, and the excision is completed with the chisel. If possible, suture the mucous membrane of the floor of

FIG. 37.

the mouth to that of the cheek. Close the cutaneous wound after providing for drainage.

III. RESECTION OF ONE-HALF OF THE INFERIOR MAXILLA.

Transfix the tongue with a stout thread for purposes of traction. Make a vertical incision in the middle line through the chin, beginning a little below the edge of the lower lip and ending on the lower edge of the jaw. Do not include the margin of the lower lip in the cut unless compelled to do so by the size of the tumor.

From the lower end of the vertical incision make a cut along the inferior edge of the jaw to its angle. If necessary, continue the cut up the posterior edge of the ascending ramus of the jaw to a point not less than one fingerbreadth below the lobe of the ear. Before the facial artery is divided it should be ligated.

With periosteal elevators, scissors, and knife separate the soft parts from the outer side of the bone to be removed. If the operation is for the removal of a tumor, sacrifice the periosteum.

Choose the line in which to divide the bone anteriorly, extract any teeth which may be in the way, and divide the bone with the Gigli wire or finger saw after the soft parts have been separated from both sides of the bone along the line of section. Pull the jaw downwards and outwards and separate the soft parts from its inner surface (mylohyoid, geniohyoid, and internal pterygoid muscles, submaxillary gland, etc.). Pull the jaw downwards, expose the coronoid process, and divide its attachments to the temporal muscle. It may save time and be easier to cut through the coronoid process with bone forceps than to separate the temporal muscle from it.

By blunt dissection separate the masseter muscle and the parotid gland from the ascending ramus. With a twisting movement directed downwards and outwards tear the head of the bone out of its bed and the active part of the operation is completed. Attend to hemostasis. If possible, suture the mucous membrane of the floor of the mouth to that of the cheek. Close the external wound after providing for drainage.

The after-treatment consists in endeavoring to keep the mouth clean by means of frequent washing with mild antiseptic solutions, in nourishing the patient, and in encouraging him to sit or walk about at as early a date as possible.

After any of the operations in which one-half of the inferior maxilla or a segment of it is removed deformity results and the teeth of the lower jaw no longer articulate with their fellows above. Some surgeons or dental surgeons have managed by a long and painful process to push the fragments of the lower jaw back into their normal position after healing has taken place and have maintained the position by means of a plate or of bridge-work. Partsch,* after removing a segment of the lower jaw, keeps the ends of the bone in correct position by means of a perforated metal plate united to the bone by a couple of wire stitches. (See Fig. 38.) The metal plates are protected with

* "Archiv f. klin. Chir.," lv, 746.

rubber tubing, and the mucous membrane of the floor of the mouth and of the cheek are sutured together *below* the metal plate so that the latter lies exposed in the oral cavity. As soon as a proper dental apparatus or plate can be made and properly fitted, the temporary metal plates are removed. Berndt, in cases where half the inferior maxilla has been removed, replaces it with an apparatus of celluloid. After the bone has been removed he sutures the mucous membrane of the floor of the mouth to that of the cheek, packs the wound, and lays silkworm-gut cutaneous sutures in position but does *not* tie them. After the lapse of about ten days he takes a celluloid ring pessary, softens it by boiling, moulds it to the proper shape, and puts it into the wound so that one end is in the glenoid cavity while the other rests against the sawed surface of the remnant of the lower jaw. He next closes the skin-wound and ties the sutures already in place, thus completely covering the celluloid apparatus. Berndt reports that slight suppuration often takes place anteriorly from irritation to the sawed surface of bone, but that if a small portion of the celluloid is then cut away by forceps, a little fibrous tissue forms between the bone and the foreign body, and the wound heals. One patient* seven months after operation claimed to have celebrated Christmas by cracking nuts with his jaw, one-half of which was celluloid, and to have suffered no ill consequences.

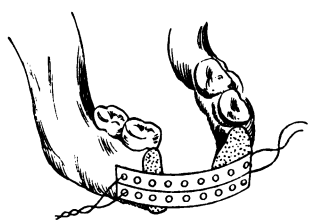


FIG. 38.

H. Nimier† gives an admirable description of Martin's prosthetic apparatus suitable for use after even very extensive excision of the inferior maxilla. He says: Provided with a segment of maxilla formed out of hard rubber, moulded in advance to represent the bone to be excised, the surgeon cuts and fashions it so

* "Archiv f. klin. Chir.," lvi, 210.

† "Traité de Chir.," Delbet and Le Dentu, v, 793.

as to fit between the remaining portions of the bone and to re-establish the exact shape of the inferior maxilla. Two small platinum plates at each end of the apparatus are attached to the bones by screws, and, acting as *fish-plates* between the bone and the substitute for bone, keep the latter in position. If much of the ascending ramus has been removed, the anterior portion of the apparatus is fixed to the remnants of the coronoid process, while that portion corresponding to the articulation is left unattached. To assure solidity in such cases it is necessary to attach the apparatus to the palate by a moulded plate. On the upper edge of the apparatus a band of hard rubber roughly simulates the teeth. It is necessary to disinfect the tissues in which the foreign body is implanted, and for this purpose the apparatus is perforated in various directions, so that irrigation is easy. Fig. 39 shows apparatus used after an almost complete excision of the lower jaw. The above description applies to the implantation of a temporary splint. When cicatrization is complete, a permanent one replaces it. The permanent apparatus is merely a more elaborate edition of the temporary. In cases of extensive excision the apparatus may be introduced in two parts, which are then united by fish-plates and screws.

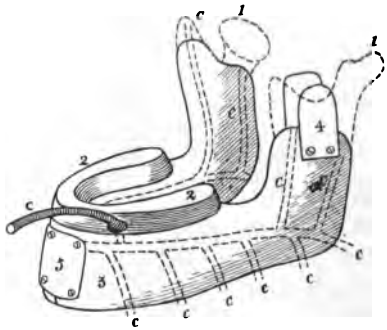


FIG. 39.

1. Articular process lower jaw. 2. Hard-rubber ridge representing teeth. 3. Artificial lower jaw. 4. Fish-plate uniting remnants of bone to the apparatus. 5. Fish-plate uniting the two halves of the apparatus. c. System of tubes for irrigation.

Such extremely ingenious and complicated prosthetic devices will rarely be available when required, and if available, must rarely be serviceable. The tissues do not tolerate foreign bodies well for any length of time, and especially mobile bodies, such as described above. They have been described here more as examples of surgical ingenuity than as practical aids.

ANCHYLOSIS OF TEMPORO-MAXILLARY JOINT.

The usual procedure for the operative treatment of bony anchylosis of the temporo-maxillary joint consists in mere excision of the condyle of the lower jaw. Helferich, having had poor results from the above operation, modified it slightly. His modification is founded on the fact that interposition of muscle between the fragments is a common cause of non-union in fractures.

Helferich's Operation.—Make a vertical incision 1½ to 2 inches in length, one fingerbreadth in front of the ear. Ligate the temporal artery. Push the parotid gland aside; expose the condyle and neck of the lower jaw. The temporo-maxillary joint may be indistinguishable because of anchylosis. With a chisel divide the neck of the bone at a point about one-half inch below the site of the joint. Do not preserve the periosteum. Excise the condyle and neck of the jaw above the point of section, taking away the periosteum with them. If only one joint is anchylosed, the mouth can now be easily opened. If necessary, enlarge the skin-incision upwards. Reflect a long flap from the temporal muscle, about one inch wide and with its base below. Turn the flap downwards so that its free end can be tucked into the defect left by the excision of the condyle. To turn the flap down and put it in position requires that a portion of the zygomatic arch be removed. This is easily done with rongeur or bone forceps. Fix the muscular flap in position by a few sutures of catgut. Close the wound without drainage. Apply dressings. The result obtained from Helferich's operation was most happy. Murphy's experience seems to show that a flap of fat is preferable to muscle in the above operation.

L. W. Arlow* finds that in severe cases of temporo-maxillary anchylosis the pathological changes are by no means limited to the joint, but that osteitis alters the form, size, and relations of the articular process, the coronoid process, the incisura semi-

* Ref. "Centralblatt f. Chir.," 1903, No. 28.

lunaris, the zygoma, etc. As a consequence simple division of the articular process is insufficient to give motion, and even when combined with osteotomy of the coronoid it often fails and resection of a part of the full width of the upper portion of the ascending ramus becomes necessary. Facial paralysis is more common as a result of tearing and distraction than of accidental division with knife or chisel. Recurrence is avoided by extensive removal of bone, by the implantation between the fragments of muscle or even of metal plates, and by early passive and active motion.

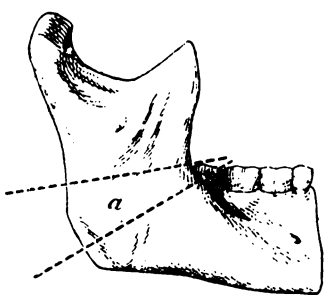


FIG. 40.—(*After Monod and Vanverts.*)

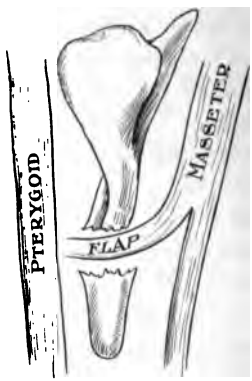


FIG. 41.—(*After Monod and Vanverts.*)

Monod and Vanverts strongly recommend osteotomy of the ascending ramus as being easier than resection of the neck of the bone, as efficient and not liable to cause injury to the facial nerve. Rochet's method of operating is as follows:

Step 1.—Make an incision bordering the angle of the jaw. About one inch of this incision runs along the lower edge of the horizontal ramus, and about one inch along the posterior edge of the ascending ramus. Through this expose the inferior insertion of the masseter and detach it from below upwards with an elevator. This exposes the outer surface of the bone. In the same way expose the inner surface of the bone by separating the insertion of the internal pterygoid.

Step 2.—With chisel, forceps, or Gigli saw divide the bone along the lines marked in Fig. 40, and remove the bone between the lines of section. The amount of bone removed should be as great as possible, to permit wide range of motion subsequently.

Step 3.—From the deep surface of the masseter dissect a flap about 1½ inches long, with its pedicle above, consisting of about half the thickness of the muscle. Pass the free end of this flap through the breach in the bone and suture it to the pterygoid (Fig. 41). Should the flap from the masseter be insufficient for the purpose, a subsidiary flap may be taken from the pterygoid.

Step 4.—Close the wound.

CHAPTER VI.

EXCISION OF THE CHEEK.

If a tumor is located on the buccal surface of the cheek, is not extensive, and does not involve the skin, it may be excised through the mouth by an elliptical incision and the wound closed by sutures. Should the amount of mucous membrane and subjacent tissue removed be great, then, when healing has taken place, there may result fibrous anchylosis of the jaw. To prevent this contraction, one must fill the defect by means of a graft

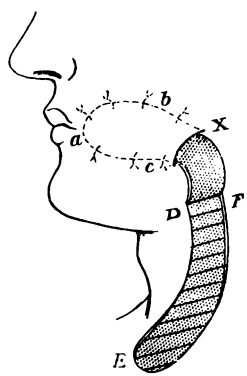


FIG. 42.

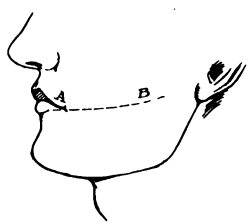


FIG. 43.

covered with epithelial tissue. Of course, when the anchylosis is the result of an old burn or such like lesion one must excise the scar tissue before implanting the graft.

The Operation.—The tumor or old scar tissue has been excised through the mouth, leaving the defect a, b, c (Fig. 42). On the neck trace the flap D, E, F, the distal portion of which consists of hairless skin large enough to more than fill the defect.

Dissect free the flap outlined. Be sure that the pedicle is wide, thick, and so placed that when turned into position its vessels will not be injuriously twisted. Make an incision (X, Fig. 42) through the cheek into the mouth. Through this incision pass the flap D, E, F, and suture its edges to the margins of the defect a, b, c. After the lapse of ten days divide the pedicle of the flap at X and replace its remnant in its normal position. Close the wound in the cheek. Close the wound in the neck partly by sliding the edges towards each other and partly by skin-

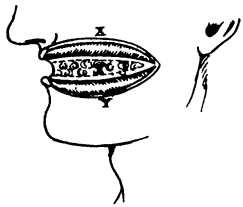


FIG. 44.

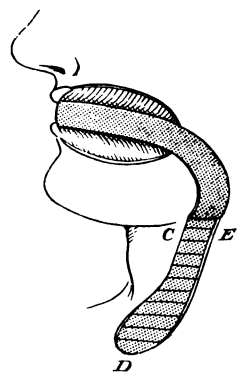


FIG. 45.

grafts. [This closure of the wound in the neck may properly be attended to at the original operation.]

When it is impossible to remove the tumor through the mouth, although the skin is not involved, one may make the incision A, B (Fig. 43) through the skin alone, reflect the skin-flaps X, Y (Fig. 44), and thus expose the mucous membrane and tumor (T, Fig. 44). Next, excise the tumor and fill the resulting defect by the flap (C, E, D, Fig. 45) taken from the neck (or forehead). Replace the flaps X and Y and secure with sutures.

Bardenheuer has devised some excellent and ingenious methods of repairing defects in the cheek, defects left after the removal of disease or of scar tissue which gave rise to fibrous anchylosis.

Fig. 46 represents a case in which the mucous membrane was replaced by a flap of skin taken from the forehead and provided

FIG. 46.

FIG. 47.—(*Monod and Vanverts.*)

Fig. 48.

Fig. 49.

FIGS. 48 AND 49.—KRASKE'S OPERATION.—(*Esmarch and Kowalzig.*)

with an enormously wide and reliable pedicle; the skin was replaced by a flap of skin taken from the neck. After healing was

secured the pedicles were divided, the wound trimmed, and all raw surfaces on forehead or neck covered by skin-grafts. Fig. 47 represents a case in which Bardenheuer brought a skin-flap down from the forehead. The flap was nourished through a narrow

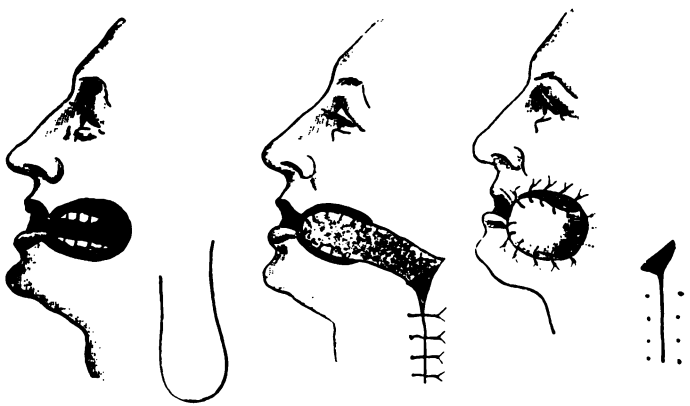


Fig. 50. Fig. 51. Fig. 52.

FIGS. 50, 51, 52.—ISRAEL'S OPERATION.—(*Esmarch and Kowalzig.*)

flap which contained the supraorbital artery. The defect in the skin was covered by a flap taken from below.

The above operations are described as suggestive types for the repair of defects in the cheek. The operations of Kraske and Israel are also good types (Figs. 48, 49, 50, 51, 52).

CHAPTER VII.

LOWER LIP.

Epithelioma is the most common cause for removal of the lower lip. The classical method of **removing labial cancers** is by a V-shaped incision. This method is applicable to cases in which not more than two-thirds of the width of the lip is involved. The resulting deformity is slight.

The operation is performed as follows: A general or local anæsthetic having been administered, an assistant controls the coronary arteries with his fingers and thumbs; the surgeon rapidly cuts through the whole thickness of the lip on each side of the tumor. The two cuts thus made meet at an angle below the tumor, which is now removed. Before the assistant relaxes his control of the coronary vessels the surgeon applies silk or silkworm-gut sutures, either through the whole thickness of the lip or with the exception of the mucous membrane. The sutures are tied and form a sufficient guard against hemorrhage.

When performed as above, the operation is very speedy; so speedy, in fact, that the surgeon may inadvertently make his incision approach a little too close to the tumor. In such operations there is usually nothing to be gained and much may be lost through great speed. A slight modification in operating leads to greater deliberation and hence greater thoroughness.

The surgeon seizes the tumor and lower lip between the finger and thumb of the left hand, and pulls them forwards and upwards in such a way as to guard against blood entering the mouth. Beginning on the lip margin, at least one-fourth of an inch from the growth, a curved incision is made downwards until the lower limits of the tumor are passed. This incision is made

to but *not through* the mucous membrane. Bleeding vessels are caught up with hemostats. A similar incision is made on the opposite side, and only after all bleeding is stopped is the mucous membrane divided and the growth removed. The wound is closed as in the previous operation. Many surgeons prefer to stitch the mucous membrane with catgut and close the rest of the wound with silk or silkworm-gut. If there is the slightest suspicion that the submaxillary and submental glands are involved in the disease, they must be removed, and with them all the lymphatic tracts leading towards them from the tumor. The tumor, lymphatics, and glands ought to be removed *en masse*. Remember that small lymphatic glands exist in the submaxillary salivary glands, and such are early involved in the cancerous process—hence if the lymph-nodes are excised the submaxillary salivary glands should be removed with them. A continuation downwards of the incision for the removal of the tumor, the **V** incision being converted into a **Y**, and elevation of the skin on each side of the cut give excellent access to the structures requiring removal. It is wise to remove the submaxillary and submental glands in every case.

Very superficial cancers of the lip may be removed by a curved, more or less horizontal incision, the mucous membrane and skin being subsequently sewed together.

A large number of methods for the removal of cancers of the lower lip and for remedying the resulting deformity will be found sketched at the end of this article. It would be useless to try to describe many of these methods, as they are inefficient in that they do not lend themselves to the exposure and removal of the submental and submaxillary lymphatic areas. The operations of Regnier and of Charles N. Dowd, however, demand description.

Regnier's Operation.—*Step* 1.—The tumor and the *whole* of the lower lip, from one angle of the mouth to the other, are removed by a curved incision. In making this incision it is well to have all bleeding arrested before the mucous membrane is divided and the mouth is penetrated.

Step 2.—The skin and mucous membrane at the edge of the wound are united by sutures (A, Fig. 53).

Step 3.—From the lower edge of the middle of the upper lip measure downwards to the lower edge of the middle of the lower jaw (*e. g.*, call the distance 2¼ inches). From the middle of the wound (A, Fig. 53) measure downwards and mark a point the same distance below A as the mental process is below the edge of the upper lip (in our example, 2¼ inches). Take a point, B, in the middle line, ¾ inch lower than the above (*i. e.*, in our example, 3 inches below A). In the submental region or

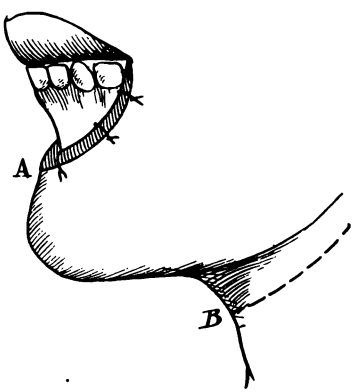


FIG. 53.

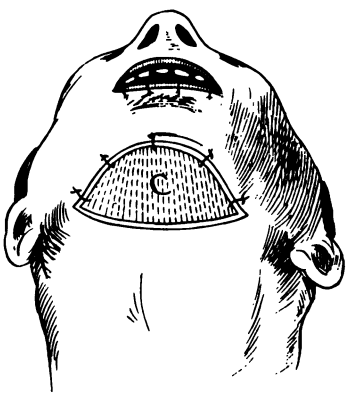


FIG. 54.

in the neck, as the case may be, make a curved incision parallel to the wound in the lower lip, and having the point B as its centre. This curved incision must be from 5 to 6 inches in length.

Step 4.—Through the incision at B dissect the skin-flap, A, B, from the subjacent tissues, in such a way as to enter the mouth at the line of reflection of the mucous membrane from lip or cheek to gum. In this way a vizor-shaped or double-pedicled flap is formed and can be slid over the lower jaw to reform the lower lip. The lower edge of this flap is sutured to the periosteum at the lower edge of the jaw (Fig. 54).

Step 5.—A space, C, is left in the submental region through which any enlarged glands may be removed. Ogston maintains that, when the submaxillary gland is enlarged and even slightly adherent to the bone, the bone is probably already involved in the disease and ought to be removed. If this is the case, then it is quite feasible to remove the whole thickness of the bone involved, along with the gland, through the triangular space C. The skin of the neck being very lax and mobile, it is a simple matter to cover at least a large part of the space C with skin. Any uncovered portions may be grafted according to the Thiersch method.

Dressings.—Iodoform gauze should be loosely packed between the newly formed lower lip and the upper part of the external surface of the lower jaw. Externally the usual antiseptic dressings may be applied. The mouth should frequently be washed with a weak solution of permanganate of potash and the dressings changed as required.

Regnier's operation is capable of being modified to meet many conditions, and very great deformities may often be avoided by its means. To the writer it has given great satisfaction.

DOWD'S OPERATION.

Step 1.—Make the incisions A, B and B, D below and parallel to the lower jaw. Be careful to leave the point X (Fig. 55) attached to the jaw. Expose and remove the fatty and lymphatic tissue of the whole submental and submaxillary region. Remove also the submaxillary salivary glands. If the lymphatics above mentioned are visibly and palpably enlarged, continue the incisions backwards and expose the carotid packet of vessels. Remove the lymphatic glands in this region whether they are palpably enlarged or not.

Step 2.—Remove the disease by means of the incisions A, E, F; C, G, H; A, C. These incisions should be ½ to ¾ inch distant from the disease.

Step 3.—Make the incisions I, E and G, K (each two inches

or more in length), down to but not through the buccal mucosa. Divide the mucosa along lines at least ⅓ inch higher, so as to form a flap which may be stitched to the skin and serve as mucous membrane for the new lower lip.

Step 4.—Unite the raw surface A, E to C, G with sutures. The wedge-shaped incisions L and M may aid in the approximation of the new lower lip.

Step 5.—Close the wounds A, B and C, D, after providing for drainage.

Trendelenburg's position ought to be used throughout the

FIG. 55.—DOWD'S OPERATION.

operation. In operating on cancer of the lip it is a good rule, where possible, to begin by dissecting out the lymphatics which *may* be diseased. It is, of course, imperative to remove all evidently involved lymphatics, but it is prudent to go further and remove the *apparently* unaffected ones next in order. For example: the submental and submaxillary group of lymphatics appear healthy, or but very slightly diseased: remove them and then excise the primary disease of the lip as well as the fatty connections between the primary and the secondary foci of disease; again, the submental and submaxillary group are evidently diseased: expose the carotid group of lymphatics, excise them,

as well as the submaxillary, etc. One great reason for beginning with the lymphatics is that by so doing the mouth is not penetrated until the difficulties of the operation are practically ended.

CHIN AND JAW.

Occasionally an operable cancer involves the soft parts of the chin, the floor of the mouth, and a portion of the lower jaw. The following method has proved useful in such cases:

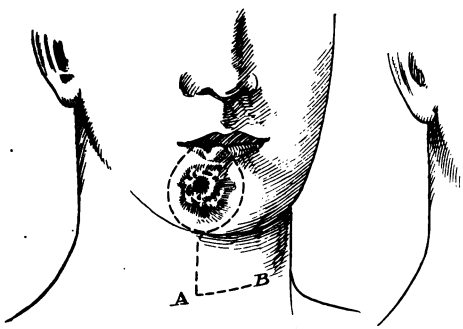


FIG. 56.

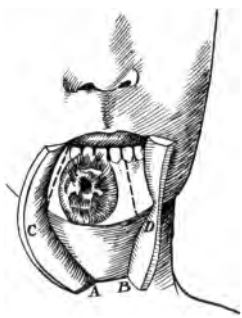


FIG. 57.

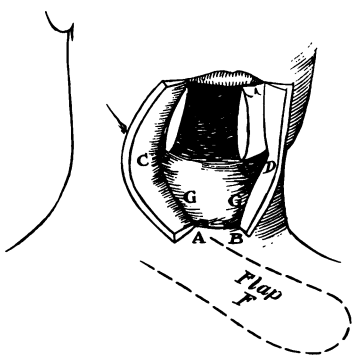


FIG. 58.

Step 1.—A stout thread is passed through the tongue so as to have command over that organ.

Step 2.—An incision is made through the skin around the tumor. From the lowest part of this a cut is made downwards through the skin of the submental region and neck to the point A (Fig. 56). The cut A, B, is made through the skin. The incision around the tumor is deepened until the bone is reached,

Fig. 59.

Fig. 60.

FIGS. 59 AND 60.—BRUNS.—(*Esmarch and Kowalzig.*)

Fig. 61.

Fig. 62.

FIGS. 61 AND 62.—ESTLANDER.—(*Esmarch and Kowalzig.*)

but the mouth should not be penetrated until all bleeding vessels have been caught. By proceeding thus, time is not wasted by the necessity of swabbing blood from the pharynx.

Step 3.—The flaps A, C and B, D (Fig. 57) are reflected, giving easy access to the bone. The horizontal ramus of the lower jaw is divided by a chain or finger saw on each side of the tumor.

Step 4.—Posteriorly to the tumor and from below upwards the floor of the mouth is divided in such a manner that all bleeding

Fig. 63.

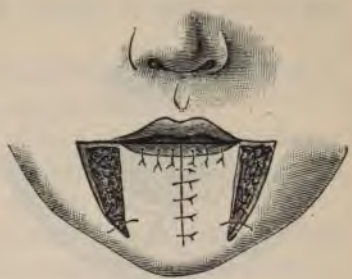


Fig. 64.

FIGS. 63 AND 64.—DIEFFENBACH.—(*Esmarch and Kowalzig.*)

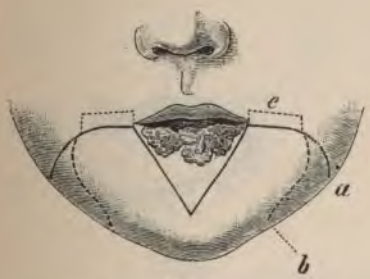


Fig. 65.

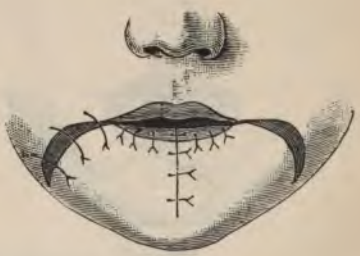


Fig. 66.

FIGS. 65 AND 66.—(*a*) JAESCHE; (*b*) TRENDELENBURG.—(*Esmarch and Kowalzig.*)

Fig. 67.

Fig. 68.

FIGS. 67 AND 68.—BUROW.—(*Esmarch and Kowalzig.*)

Fig. 69. Fig. 70.

FIGS. 69 AND 70.—BLASIUS.—(*Esmarch and Kowalzig.*)

Fig. 71. Fig. 72.

FIGS. 71 AND 72.—LANGENBECK.—(*Esmarch and Kowalzig.*)

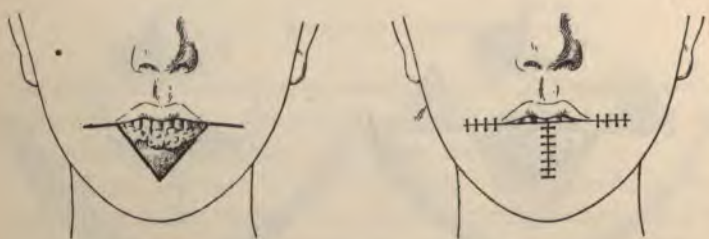


Fig. 73. Fig. 74.

FIGS. 73 AND 74.—TRÉLAT.—(*Monod and Vanverts.*)

is *invited* and arrested before the scissors or knife enters the mouth.

Step 5.—It is now easy to remove all the diseased structures—chin, jaw, floor of mouth, glands, etc., *en masse*.

Step 6.—If possible, the edges of the oral mucous membrane should be united by silk or catgut sutures. The skin-wound is closed by silkworm-gut.

Dressings.—The floor of the mouth should be lightly packed with iodoform gauze. The external wound should be covered by an *antiseptic* dressing. Frequent washing of the mouth with a weak permanganate of potash solution is necessary. Food ought to be given through the stomach-tube, though the patient may

Fig. 75.

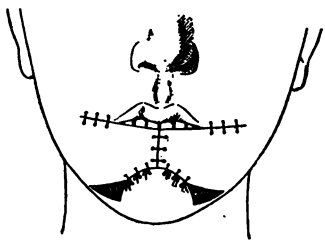


Fig. 76.

FIGS. 75 AND 76.—SERRE.—(*Monod and Vanverts.*)

drink water if he so desire. It is important in all such cases to encourage the patient to leave his bed as early as possible. This helps to avoid the great danger in such cases, viz., septic pneumonia.

Should the first part of Step 6 of the previous operation be impossible owing to lack of mucous membrane, then an attempt may be made to supply the defect as follows. In the neck (where hairs are absent) trace out a flap of skin (F, Fig. 58) in such a position and of such a size that, allowing for shrinkage, it can be made to fit into the floor of the mouth. Turn the flap F up and stitch its *distal* or free end to the *anterior* portion of the mucous membrane wound. The most posterior stitches unite the mucous membrane of the side of the mouth near the root of the

tongue to the raw edges of the flap near its pedicle. This gives an epithelial lining to the floor of the mouth. The flaps A, C and B, D (Fig. 58) are now sutured over flap F; both flaps, A, C and B, D, having been split (G, Fig. 58) to permit the passage of flap F into the mouth. The wound left by the transplantation of flap F is to be closed by sutures or by Thiersch's skin-grafts. Of course, a secondary operation will be necessary to close the hole G (Fig. 58) and to divide the pedicle of flap F.

Several well-known methods of excising the lower lip and repairing the defect are illustrated by Figs. 59 to 76.

CHAPTER VIII.

HARE-LIP.

Time to Operate.—On the whole, it may be taken that it is better to operate after the patient has passed the first two months of life than at an earlier period, although many surgeons operate by choice within a week or two of birth.

Position of Patient and Surgeon.—Chloroform having been administered, the patient should be put in Rose's position. The shoulders being supported on a pillow, the head is allowed to hang backwards over the end of the table. In this posture the anterior nares are at a *lower* level than the entrance to the trachea, and thus it is easier for blood which has gathered in the nose or pharynx to escape through the nares than to be aspirated into the lungs. For the same reason much trouble caused by the collecting of blood in the pharynx is obviated. Trendelenburg's position has the same advantages. The surgeon sits with his back to the window, opposite the patient's head. The first assistant stands beside the patient's left shoulder.

Fundamental Principles of Hare-lip Operations.—1. Tension must be relieved, so that the function of the sutures is practically merely to hint to the edges of the cleft that they must stay in apposition.

2. The edges of the cleft must be freshened so that union can take place.

3. This freshening must be done in such a way that the edge of the upper lip opposite the line of suture is made to project below the normal level of the lip. The object of this is to avoid the occurrence of a notch on the lip after the wound has shrunk when healing is complete.

Fig. 77.

Fig. 78.

FIGS. 77 AND 78.—MALGAIGNE.—(*Esmarch and Kowalzig.*)

Fig. 79.

Fig. 80.

FIGS. 79 AND 80.—NÉLATON.—(*Esmarch and Kowalzig.*)

Fig. 81.

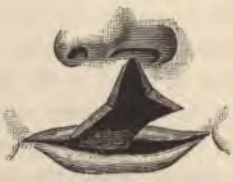


Fig. 82.

FIGS. 81 AND 82.—MIRAULT.—(*Esmarch and Kowalzig.*)

FIG. 83.

FIG. 84.

4. The freshened edges of the cleft must be brought together and kept together.

SINGLE HARE-LIP.

Incomplete Hare-lip.—The cleft in the lip does not extend into the nostril; it is often a mere notch. It may be unnecessary to relieve tension, though when the cleft is at all extensive or wide this is necessary and must be done thoroughly. Malgaigne's operation gives good results, but Nélaton's is the one usually recommended. These operations and a few others will be easily understood by a glance at Figs. 77, 78, 79, 80, 81, 82.

FIG. 85.

FIG. 86.
The dotted area represents the extent of dissection that is commonly required for the relief of tension.

In incomplete hare-lip, when the ala of the nose is pulled to the side and the nostril much widened, C. H. Mayo relieves tension very thoroughly, separating the ala of the nose from its deep connections; then he makes his denudation at the floor of the nostril (Fig. 83, A, B), and by pulling the lip downwards and introducing sutures, converts the horizontal wound A, B into a vertical one (Fig. 84). The result is obliteration of the notch in the lip and correction of the deformed position of the ala of the nose.

Complete Single Hare-lip.—*Relief of Tension.*—This is one of the most important steps of all hare-lip operations. Failure to relieve tension completely is the most common cause of bad results.

The upper lip is everted and pulled upwards and outwards by the finger and thumb of the left hand (Fig. 85). The mucous membrane is incised at its reflection from gum to lip, and divided from the premolar region on one side to the premolar region on the other side, if necessary. Through this incision, with knife or scissors, one separates the soft parts from the bones (keeping the instrument close to the bone). Particular attention must be paid to the separation of the ala of the nose from the bone (Fig. 86).

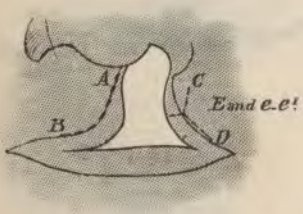


Fig. 87.

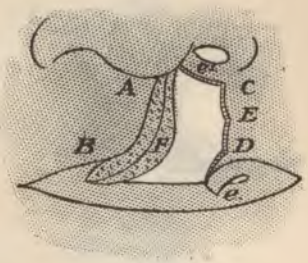


Fig. 88.

To what extent must the soft parts be separated from the bone? The answer to the foregoing question is—until the edges of the cleft in the lip, when placed together, show a tendency to lie in apposition, so that the sutures when introduced may be tied without giving rise to tension.

Freshening of the Edges of the Cleft.—The methods of freshening the edges of the cleft are legion. Only one of the methods, viz., Collis', will be described here.

The Collis Operation for Single Hare-lip.—Tension having been relieved, make the incision A, B (Fig. 87) along the line of junction between mucous membrane and skin. Dissect the mucous membrane, corresponding to that incision, from the subjacent tissues until the whole edge A, B of the cleft is raw.

The mucous membrane may be entirely removed or may be left as a flap (F, Fig. 88) having its pedicle posteriorly. If the flap is left attached, it forms, when the operation is completed, a sort of valve covering the posterior surface of the wound. In a few weeks no trace of it will be found.

On the external edge of the cleft make the incision C, E, D (Fig. 87) through the whole thickness of the lip. At the point E divide the flap thus formed by a horizontal incision. This results in the formation of two flaps, C e′ and D e (Figs. 87 and 88). Stitch the raw surface of the flap C e′ to the highest possible part of the raw surface A, B. This brings the ala of the nose into good position and provides an epithelial covered floor to the anterior

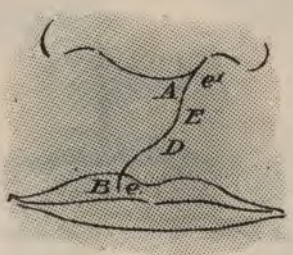


FIG. 89.

nares. Turn the flap D e (Fig. 88) downwards and stitch it to the lowest possible part of the raw surface A, B. Stitch the point E (Fig. 88) to the middle of the raw surface A, B. When all the sutures are in place and tied, the wound line will appear as represented in Fig. 89.

This operation wastes no valuable tissue and gives a particularly long upper lip. Figs. 90 to 98 suffice to illustrate some other well-known methods of operating.

Sutures.—One or two deep sutures involving almost the whole thickness of the lip must be inserted. The best material for these is silkworm-gut. Hare-lip pins have been discarded, as they cause too much scarring. Usually the deep sutures are inserted through the skin and give rise to considerable scarring at their

points of entrance and emergence; a better plan is to introduce the *deep* sutures from the mucous surface and *not* to involve the skin in their bite; when this is done, these stitches must not be removed until healing is complete, when they will generally be found

Fig. 90. Fig. 91. Fig. 92.

FIGS. 90, 91, AND 92.—GIRALDÈS.—(*Esmarch and Kowalzig.*)

Fig. 93. Fig. 94. Fig. 95.

FIGS. 93, 94, AND 95.—KÖNIG.—(*Esmarch and Kowalzig.*)

Fig. 96. Fig. 97. Fig. 98.

FIGS. 96, 97, AND 98.—(*Esmarch and Kowalzig.*)

to have cut their own way out. If the surgeon endeavors to remove such sutures at the end of a week, he requires to evert the lip, and thus jeopardizes the line of union. Several superficial cutaneous sutures must be introduced; the best material for these is horse-hair. Horse-hair sutures, because of their elasticity, leave

less scar than any others. All cutaneous sutures (superficial and deep) may be removed by the seventh day.

DOUBLE UNCOMPLICATED HARE-LIP.

When the deformity is not complicated by the central portion of the lip being carried forwards towards the tip of the nose by

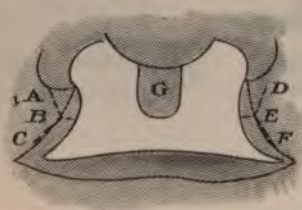


FIG. 99.

FIG. 100.

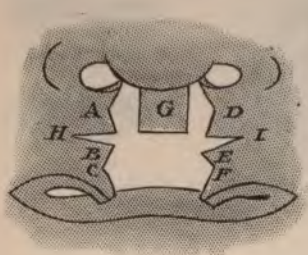


FIG. 101.

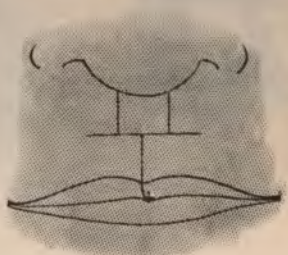


FIG. 102.

the intermaxillary bone, the following operation will generally be found satisfactory.

Make the incisions A, B, C and D, E, F (Fig. 99) through the whole thickness of the lip. At the points B and E divide each of the flaps thus formed into two. The edges of the central portion of the lip (Figs. 99, 100, 101, G) are now to be pared. On each side there are now two flaps, an upper and a lower. The raw surfaces of the upper flaps are to be sutured to the lateral raw surfaces of G (Fig. 100) as high up as possible. Corresponding

to the lower edge of G, the horizontal incisions H and I (Figs. 100 and 101) must be made through the whole thickness of the lip on each side. This procedure permits the easy approximation of

Fig. 103. Fig. 104. Fig. 105.

FIGS. 103, 104, AND 105.—MAAS.—(*Esmarch and Kowalzig.*)

Fig. 106. Fig. 107. Fig. 108.

FIGS. 106, 107, AND 108.—HAGEDORN.—(*Esmarch and Kowalzig.*)

Fig. 109. Fig. 110. Fig. 111.

FIGS. 109, 110, AND 111.—(*Esmarch and Kowalzig.*)

the edges of the cleft below the level of the central part (G). The two lower flaps when their raw surfaces are sutured together form a prominence on the edge of the new upper lip. The appear-

ance of the wound when the operation is completed is represented in Fig. 102. Other methods of operating are sufficiently illustrated by Figs. 103 to 111.

DOUBLE HARE-LIP COMPLICATED BY THE PRESENCE OF THE INTERMAXILLARY BONE HANGING AT THE TIP OF THE NOSE.

Some surgeons advise that the misplaced intermaxillary bone be entirely removed. When this has been done, it is very difficult to secure union between the new-formed upper lip and the column of the nose. Undoubtedly it is wise to retain the bone and

FIG. 112.—(*Esmarch and Kowalzig.*)

replace it in its proper position. An incision (Fig. 112) is made through the muco-periosteum of the nasal septum, beginning immediately behind the intermaxillary bone and extending backwards for three-fourths of an inch. A fine periosteal elevator or probe is passed through this incision and the muco-periosteum raised on each side of the septum (Figs. 113 and 114) from its edge up to the root of the nose. With a strong pair of scissors a triangular piece of the septum (Fig. 113) is now excised. This permits the intermaxillary bone to be easily pushed back into position. It is not absolutely necessary to trim off the mucous membrane covering the intermaxillary bone and those portions of the superior

maxilla with which it is in contact, though it is advisable to do so, as union can then take place with rapidity. If any developing teeth are encountered, remove such. Teeth which appear later in bad position are to be treated by a dentist. Suture of the bone in position is unnecessary. The cleft in the lip should be united at the same sitting.

FIG. 113.—(*Esmarch and Kowalzig.*)

FIG. 114.—(*Esmarch and Kowalzig.*)

Sometimes instead of excising a wedge from the septum it is sufficient to make a vertical cut through it and slide that portion of the septum anterior to the cut back alongside the posterior portion (Fig. 114).

DRESSINGS AFTER OPERATIONS FOR HARE-LIP.

Should tension on the sutures be feared, a strap of adhesive plaster may be placed from cheek to cheek across the upper lip, in such a way as to relieve tension. If, however, the soft parts of the lip and cheeks have been sufficiently separated from the bones at the beginning of the operation, then such a measure is unnecessary and undesirable, as it simply irritates the already irritable patient. It is not necessary to apply any dressing to the wound, as nature soon seals it with dried blood-clot. Until the sutures are removed there should be as little interference with the wound as possible. If it is going to heal, it will heal under the scab, and the best intentioned endeavors to clean the wound

will merely interfere with nature's work and do no good, as cleanliness can never be attained in such cases. Care must be taken so to fix the little patient's arms that scratching of the wound is rendered impossible.

When it is desired to close the cleft in the palate, which almost invariably accompanies extensive hare-lip, such closure ought to be effected either at the same time as the intermaxillary bone is replaced or at a former operation. Under such circumstances the hare-lip ought *not* to be corrected until the palate is healed.

CHAPTER IX.

CLEFT PALATE.

The proper time to operate for cleft palate is when the patient is under three months of age; the best method of operating is inapplicable in children of over six months. Brophy has operated on 211 cases of cleft palate in babies younger than six months without a single death, yet the operation is undoubtedly not without risk. The operation should be performed before the closure of the concomitant hare-lip. Brophy gives the following reasons for the above practice: (1) The existence of the hare-lip gives more room in which to work. (2) There is less nervous shock after an operation on a child of a few weeks of age than when the babe is older. (3) The bones are soft. (4) After operation the child will be better nourished. (5) The muscles of the palate are given an opportunity to develop instead of atrophy, and the patient does not get into the habit of articulating through the cavern of the nose.

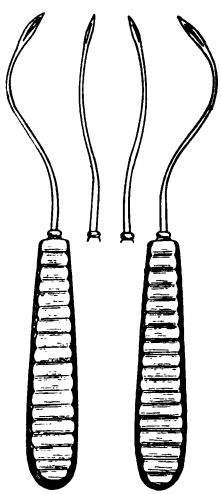


FIG. 115.—(*Brophy, "Dental Cosmos."*)

Before operating see that the patient's general health is good and that no local conditions exist which might interfere with repair. If adenoids are present, they must be removed. For a few days prior to operation it is well to cleanse the mouth and nasal cavity with a saturated solution of boracic acid in glycerin.

Brophy's Operation.—Applicable in children younger than three months; generally possible, though not so easy, in children

up to, but not beyond, the sixth month. The only special instruments required are two of Brophy's strong needles (Fig. 115); a few strands of No. 20 silver wire; lead plates No. 17, American gage. No special mouth-gag is necessary, the assistant's fingers being sufficient to keep the mouth open and the tongue depressed. Immediately before operating the writer swabs the parts with adrenalin solution. This lessens hemorrhage. During operation bleeding is easily controlled by pressure with pledgets of gauze wrung out of hot water.

The Operation.—1. Anæsthetize the patient. Place in Rose's

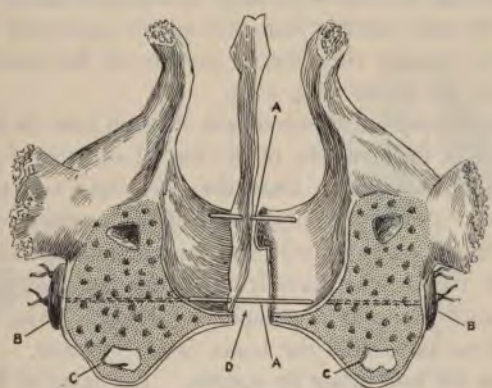


FIG. 116.—(*Brophy, "Dental Cosmos."*)

or the Trendelenburg position. Pass a stout thread through the anterior end of the tongue as a traction suture. This is a great convenience.

2. With a knife pare thoroughly the edges of the cleft in the hard palate, cutting away a little of the bone itself to insure thoroughness. Either pare or horizontally split the edges of the cleft in the soft palate. If split thoroughly, the edges of the split retract and so a good raw surface is left without any loss of tissue.

3. Thread a Brophy needle with strong silk or celluloid hemp. Raise the cheek and pass the threaded needle through the superior maxilla from without inwards at a point just back of the malar

process and high enough to be *above* the palate (Fig. 116). When the needle appears in the cleft, pick up the thread, which it carries, with hook or forceps. Withdraw the needle, leaving the loop of thread *in situ.* Catch the ends of the thread in a hemostat. Through a corresponding part of the opposite bone pass a loop of thread in the same manner. Pass this second loop of thread through the first and pull the latter out, carrying with it the former. We now have a loop of thread passing through both superior maxillary bones above the palate, and when necessary through the nasal septum. By means of this thread pull a strand of very strong silver wire through the same track.

4. In the same manner introduce one or sometimes two other silver wires through the anterior portion of the maxilla above the level of the palate (Fig. 116).

5. Pass the ends of the silver wire through holes in lead plates moulded to fit the convexity of the buccal surfaces of the bones (one plate on each side). Draw the wires tight and twist them together—*i. e.*, twist the "right end of the anterior wire to the right end of the posterior wire and the same on the left side."

6. With the thumbs forcibly press the two maxillary bones together until the cleft is completely closed. Twist the wires once more so as to hold the bones firmly together.

7. Close the soft palate by sutures. The state of the patient may necessitate this step being delayed until another day. Do not close the hare-lip until the palate is completely closed and the patient has recovered.

Note.—If closure of the cleft by mere compression proves impossible, division of the malar process may be practised. Make a very small incision through the mucous membrane over the malar process of the superior maxilla. Through this divide the process horizontally, *i. e.*, parallel to the alveolar edge, either with a knife or a small chisel, such as dentists use.

After-treatment consists in as great cleanliness of mouth and nose as can be attained; in the use of stimulants, if necessary; and in feeding by means of a spoon. The plates and wire sutures remain in place from two to four weeks.

In unilateral cleft palate the palatal process of one side has united with the septum of the nose. In such cases the septum is often very much curved, and its lower portion seems a continuation of the palatal process to which it is united. If, in the course of operation, it is difficult to bring the edges of the two palatal processes together, we may cut a groove in the septum at the point X (Fig. 117) and bring the freshened edge of the ununited palatal process (P, Fig. 117) into apposition with it, thus using a part of the septum to close the defect.

Uranoplasty.—In all cases of complete cleft palate after the age of six months uranoplasty is the operation of choice. The

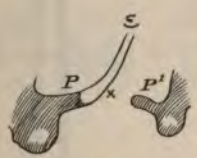


Fig. 117.

Fig. 118.

patient having been anæsthetized, placed in Rose's position, and a traction thread passed through the tongue, a suitable gag is introduced. Of the numerous gags invented, probably Whitehead's is the best, but the writer finds that a piece of wood about ¾ inch thick answers every purpose, and consequently rarely uses anything else.

1. *Denudation.*—Seize the end of the uvula on one side with a sharp hook or forceps (Fig. 118). With a sharp knife or tenotome remove a strip of mucous membrane from the whole edge of the cleft. In cutting, do so obliquely, removing rather more membrane from the oral than from the nasal side of the palate. This gives a more extensive raw surface, which is a great advantage.

When the soft palate is very thick, its edge may be split instead of pared. Repeat the process on the other side of the cleft.

2. With a suitable periosteotome or knife divide the muco-periosteum along the edge of the cleft in the hard palate. Separate all the muco-periosteum from the hard palate up to the alveolar process (Fig. 119). For this procedure Brophy's periosteotomes (Fig. 120) are convenient, but a suitable instrument is easily extemporized from a dental spatula or even an aneurysm needle.

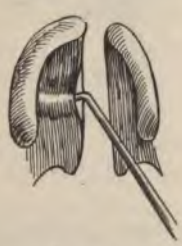


FIG. 119.

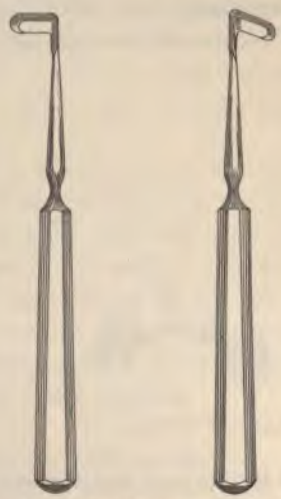


FIG. 120.—(*Brophy, "Dental Cosmos."*)

3. The soft palate may be said to consist of three layers: (*a*) The nasal mucous membrane; (*b*) the tissues attached to the posterior edge of the hard palate; (*c*) the oral mucous membrane.

Leaving intact the oral mucous membrane, which is continuous from hard to soft palate, divide with fine curved scissors both the nasal mucous membrane and the tissues attached to the posterior edge of the hard palate. This is one of the most important steps in the operation, allowing the muco-periosteal flap obtained from the hard palate to drop towards the mouth, and with it the soft

palate (Fig. 121). Repeat this procedure on the opposite side. Commonly the raw edges of the flaps thus obtained will come into apposition without tension. If they do not, it is necessary to make a lateral incision through the muco-periosteum parallel and close to the alveolus (Fig. 122) on one or both sides of the mouth, and extending from the lateral incisor back to the posterior margin of the hard palate. If this is insufficient to relieve tension, Billroth's procedure may be adopted, as follows: Pass a fine chisel through the posterior angle of the lateral incision; direct it obliquely inwards and upwards against the hamular process, and with a light blow from the hand make it divide that bone. The dislocation of the hamular process, increased if necessary by the use of an elevator, gives perfect relaxation of the velum palati and does not injure its musculature. *Incisions through the soft*

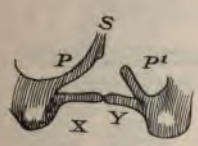


FIG. 121.

FIG. 122.

FIG. 123.

palate dividing its muscles were formerly considered necessary; *now they are never admissible.*

C. H. Mayo considers it important to make lateral incisions (Fig. 122) on both sides, not merely to relieve tension, but to permit the use of a relaxation tape. Having prepared the parts for the insertion of sutures, and having made two lateral incisions close to the alveoli, he introduces a narrow tape which surrounds the right and left muco-periosteal flaps (Fig. 122). Traction on the ends of the tape brings the flaps towards the operator, steadies them, and facilitates the introduction of the ordinary sutures. When the sutures are in place and tied, Mayo crosses the free ends of the tape and fixes them by tying a ligature around them at this point (Fig. 123), cuts off the superfluous portions of the tape, and lastly slides the whole tape until that part fastened by

the ligature lies in the nasal instead of in the oral cavity. The tape fastened as above acts as an efficient relaxation suture or support; it also drains secretions from the nasal cavity into the mouth. It is remarkable how this very simple contrivance facilitates the operation.

4. Suture. Many special needles have been devised to overcome the difficulties met with in closing palatal defects. Of these, the Deschamps (Fig. 124) is perhaps the best, although it is usually made too large. The writer finds that he can discard such special instruments by using pothook-shaped needles, grasped in a long-necked needle-holder, and passing each end of the thread, armed with a needle, from the nasal to the oral side of the palate, *i. e.*, from within outwards. The usual method of suturing is to begin at the uvula and work forwards, being careful to *evert* the edges of the wound when the flaps from the hard palate are being united. Silkworm-gut and silk are the materials used.

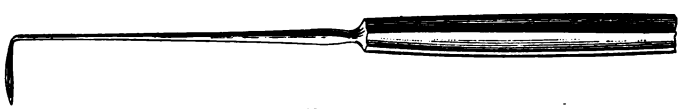


FIG. 124.

Brophy puts in, as a preliminary, tension sutures of No. 22 silver wire, fixing these on lead plates (Figs. 125 and 126). He claims that the use of these obviates the necessity of lateral incisions, and that the lead plates act as a splint, securing rest, and hence better results. The fact that numbers of Brophy's cases have passed the supreme test of successfully reading aloud before professional societies makes his opinions and procedures worthy of the gravest consideration.

After-treatment.—Liquid or soft food is alone permissible. Antiseptic sprays may be used if not annoying to the patient. The patient should get out of bed and, in suitable weather, out of doors as soon as possible. The sutures must not be removed earlier than the seventh day after operation.

Atypical Operations.—In certain cases of cleft palate the chasm is too wide and the material at command too scanty to

permit of closure by the ordinary measures. Lane's method may be taken as a type of operation suitable under such circumstances. The patient is anæsthetized and placed in Rose's position.

Step 1.—On the segment of palate which is the larger make the incision A, B, C (Fig. 127) through the whole thickness of the muco-periosteum and one half-way through the thickness of the soft palate. Reflect the flap thus outlined; its base is at the edge of the cleft.

Step 2.—On the opposite side of the cleft split the edge along

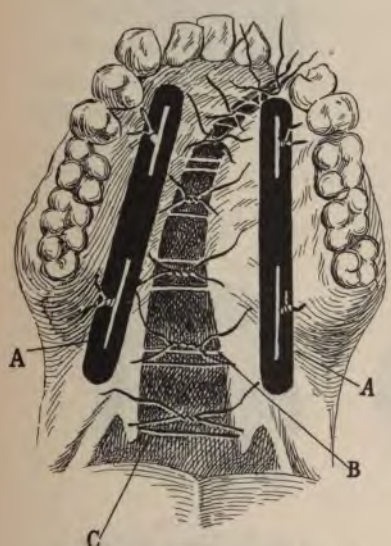


FIG. 125.—(*Brophy, "Dental Cosmos."*)

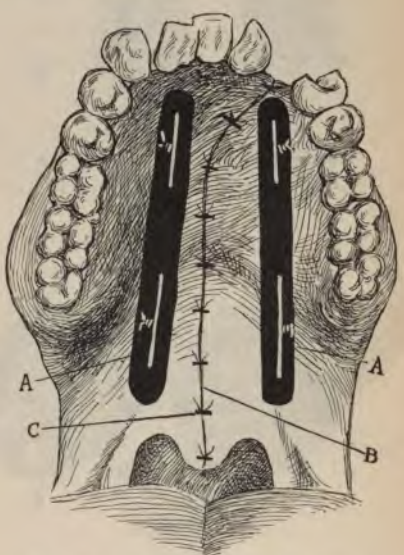


FIG. 126.—(*Brophy, "Dental Cosmos."*)

the line D, E. Separate the muco-periosteum from the bone for a short distance outwards (Fig. 127, b).

Step 3.—Tuck the free edge of flap A, B, C under flap D, E, so that a portion of the raw surface of A, B, C is flatly in contact with the raw surface of flap D, E. Suture (Fig. 128, a and b).

Lane's Operation on the Soft Palate.—If a wide gap is found to exist in the soft palate, Lane outlines the flap X, Y, Z, consisting partly of muco-periosteum from over the hard palate and partly

of the oral layers of the soft palate. He reflects this flap and sutures it to the freshened edges of the defect (Fig. 129, a and b). A modification of this operation is suitable for the closure of perforations of the hard palate.

Partial Cleft Palate.—When there is a cleft of the soft palate alone and the edges can be brought together without tension,

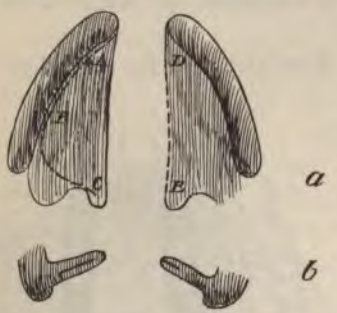


FIG. 127.

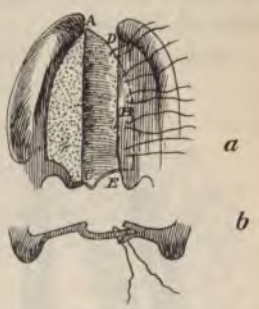


FIG. 128.

FIG. 129.

FIG. 130.

Z and Q. Line of separation of attachments of velum to hard palate. X, Y, Z, Q. Area in which muco-periosteum (continuous with the velum) is separated from the bone.

one is content to pare the edges and apply sutures. When the cleft in the soft palate reaches close to the hard or when the latter is partially cleft, it is absolutely necessary to relieve tension. This is done in the same fashion as in complete cleft palate by dividing the attachments of the velum to the hard palate and by separating the muco-periosteum from the bone to as great an extent as may be necessary (Fig. 130).

CHAPTER X.

TONGUE.

When a small tumor exists near the tip of the tongue, it may be removed by means of the **V**-shaped incision.

Dieffenbach's Operation.—Local anæsthesia usually suffices. If a general anæsthetic is used, the mouth must be kept open during the operation by a mouth-gag. Pull the tongue forwards by means of a volsellum or of a stout thread passed through its tip. At a point on each side of the tumor, and about $\frac{3}{4}$ of an inch from it, make a long silk thread pass through the whole thickness of

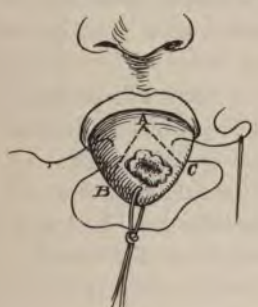


FIG. 131.

FIG. 132.

the tongue in such a manner that the loop of the thread is under the tongue, while its two free ends emerge from punctures on the dorsum (Fig. 131).

Excise the tumor and a wedge-shaped portion of the whole thickness of the tongue by the converging incisions A B, A C (Fig. 131). The excision is most easily effected with the scissors. The bleeding is now liable to be sharp. Tighten and tie the suture which has already been introduced. This stops all hemor-

rhage. Introduce a few more stitches so that the wound is neatly closed (Fig. 132).

The only after-treatment required is frequent cleansing of the mouth with non-poisonous antiseptic washes.

Excision by Elliptical Incisions.—Small tumors of the tongue may be excised under cocaine anæsthesia by means of elliptical incisions surrounding them. As soon as the neoplasm is removed, bleeding is stopped by the application of a few sutures which at the same time close the wound.

COMPLETE REMOVAL OF THE TONGUE.

As a preliminary to any operation for extirpation of the tongue it is necessary to clean the mouth. The mouth, especially in cases of cancer, is a filthy cavern. The teeth, usually decayed, are covered with tartar and other abominations. The mouth should be thoroughly washed with antiseptic solutions, the teeth vigorously brushed, or, better, cleansed by a good dentist, and loose teeth should be removed. Very many methods of operating have been devised, but only a few of them will be described.

I. Whitehead's Operation.—The following description is taken almost entirely from an article by Whitehead:

1. The patient should be placed in a sitting posture; the head, firmly held, should be inclined forwards so that blood may escape easily. The light must be good and have direct access to the mouth. The patient's mouth and the surgeon's axilla should be at about the same level.

2. During the first stages of the operation anæsthesia should be complete, but afterwards only partial insensibility should be maintained.

3. A good gag is essential. It must be one which will not slip and will not embarrass respiration. [Whitehead's gag, with the tongue depressor absent, is probably the best.] With this the mouth is opened as widely as possible.

4. A firm ligature should be passed through the tip of the tongue for the purpose of traction.

5. The tongue is retained within the mouth principally by means of the frenum and the attachments to the anterior pillars of the fauces. These and the reflection of the mucous membrane between the tongue and jaw must be divided with scissors. Should any spouting vessels be seen, they must at once be caught in forceps and twisted; general oozing of blood may be neglected, because as soon as the main arteries are discovered and twisted all bleeding ceases. "There is, in reality, no difficulty in determining the actual position of the lingual arteries, as they are practically invariably found in the same situation and it requires very little experience to seize them with a pair of forceps before dividing them." The rest of the tongue may be cut away without difficulty. Before completely removing the tongue it is wise to pass a ligature through the glosso-epiglottidean fold. This ligature may be left in place for twenty-four hours, and permits one to pull forwards the epiglottis should respiration be interfered with at any time. Traction on this ligature of itself arrests hemorrhage and makes it an easy matter to secure any bleeding vessel.

6. Wash the wound with an antiseptic solution.

7. Paint the wound with iodoform styptic varnish. The varnish is made by substituting for the alcohol ordinarily used in the preparation of Friar's balsam a saturated solution of iodoform in ether 9 volumes, and turpentine 1 volume.

After-treatment.—Encourage the patient to sit up and move about even as early as the day following the operation. Give liquid food by the mouth as early and freely as possible. If necessary, supplement oral feeding by the use of nutrient enemata. The mouth is frequently washed and the varnish is reapplied daily.

In the hands of Whitehead this operation has had remarkable primary results. Up to 1891 he had performed it 66 times with but three deaths.

When it is necessary to remove only one-half of the tongue, the operation is practically the same as above, except that the organ is split in the middle line and the diseased half alone excised.

II. Regnoli-Billroth Operation.—*Step* 1.—Pass a stout thread through the tongue for purposes of traction.

Step 2.—Make an incision through the skin and subcutaneous tissue from the anterior margin of one masseter muscle to the anterior margin of the other masseter. This incision follows the lower edge of the lower jaw (Fig. 133). Reflect the skin-flap thus outlined. The submaxillary region now lies exposed. If more room is desired, the posterior ends of the original incision may be extended backwards to the angles of the lower jaw.

Step 3.—With scissors or knife penetrate the mouth from below upwards immediately behind the symphysis. Be careful not to injure the periosteum. Separate the structures composing the floor of the mouth from the lower jaw as far back as the anterior pillar of the fauces. Any bleeding vessels are caught up by forceps and either twisted or ligated. The tongue with its traction thread is pulled out through the submental wound and its posterior connections divided with scissors.

FIG. 133.—(*Esmarch and Kowalzig.*)

Step 4.—If there is hemorrhage from the stump and it is not easy to locate the bleeding point, hook the forefinger into the pharynx and pull forwards. This simple manœuvre brings the whole stump within reach and the hemorrhage is easily controlled by forceps or suture. A few sutures of silkworm-gut judiciously inserted lessen the extent of raw surface.

Step 5.—Put an iodoform gauze drain in place and close the remainder of the wound with interrupted silkworm-gut sutures.

During this operation all affected or suspected lymphatic tissue must be removed from the submaxillary region.

III. Sedillot's Operation.—In cases of lingual cancer where the floor of the mouth and the jaws are not affected, Kocher ("Operationslehre," fourth edition) strongly advocates Sedillot's operation. The only disadvantage of the procedure is that excision of affected or suspected lymph-glands, etc., if done at the same time as the primary operation, leaves too large and irregular a wound, so that infection can scarcely be avoided. Kocher recommends that the glands be excised at a second operation. Supposing that the disease affects the edge of the tongue posteriorly and has spread to its base, to the anterior pillar of the fauces, the soft palate, and the lateral wall of the pharynx, the operation is carried out as follows:

FIG. 134.

Median division of the lower lip, chin, and skin in submental region as far as the hyoid bone (Fig. 134). Hemostasis. Division of the lower jaw in the middle line. Separation of the divided halves of the jaw with sharp hooks. Median division of the geniohyoid and genioglossal muscles. By means of a traction thread pull the tongue out and towards the sound side. Divide the mucous membrane of the floor of the mouth backwards at the margin of the tongue. This exposes the lingual vein, running backwards and outwards over the lateral surface of the hyoglossus; also the lingual nerve near the border of the tongue, immediately under the mucous membrane. The hypoglossal nerve is exposed at the outer surface of the hyoglossus, over which it runs inwards and forwards. Between the hyoglossus and genioglossus lies the lingual artery, easily recognized and tied. Divide the hyoglossus with the cautery (Kocher divides all the muscles around the tumor with the cautery). Put great traction on the tongue and, using the cautery, divide the mucous membrane posteriorly, along a

line remote from the disease. If the disease extends to the palate and pharynx, divide the styloglossus muscle, and with it the glossopharyngeal nerve. After dividing the mucous membrane in front of the tonsil it can be lifted up by blunt dissection, even when diseased, until the internal pterygoid muscle is exposed. Divide, with the cautery, the soft palate so far as it is diseased, and with it the tensor and levator palati muscles. Now divide the mucous membrane on the posterior wall of the pharynx as far as the longus colli muscle and forwards to the base of the tongue. All this can be done under full guidance of the eye. Lastly, with the cautery, divide the tongue itself, remote from the disease, and sever its nerves, muscles, and vessels (after applying ligatures), or such of these as penetrate the neoplasm. Preserve as many nerves and muscles as possible so as to interfere with deglutition to the minimal extent. Ability to swallow is the greatest preventive against subsequent pneumonia. Rub the wound with a small amount of xeroform. Wire the divided jaw. Do *not* elevate the periosteum when drilling the bone. Close the wound in the soft parts, providing for gauze drainage immediately in front of the hyoid bone. If the patient is placed in the Trendelenburg position, the operation can be done under a general anæsthetic without any preliminary tracheotomy. The operation is suitable for all cases except those in which the jaw is affected.

After-treatment.—Until the patient is able to sit up, he should be kept in Trendelenburg's position. On the day following the operation he should try to sit up and attempt to swallow tea or wine with water. Nourishment must be administered through an esophageal tube.

IV. Von Langenbeck's method of excising the tongue is very similar to that of Sedillot, and thus requires no special description, except as regards the incision. On the side corresponding to the disease make an incision from the corner of the mouth vertically downwards to the border of the lower jaw, and continue it downwards to the side of the hyoid bone (Fig. 134). The upper portion of the cut divides the lower lip and gum, penetrating to and exposing the lower jaw; the lower or submental portion at

first penetrates only the skin and superficial fascia. Through the lower part of the incision excise all suspected glands (lymphatic and salivary) and ligate the lingual artery. Divide the jaw along the line of incision after boring holes for subsequent wiring. With strong hooks separate the segments of the jaw. The tongue and floor of the mouth are well exposed by this procedure and can be dealt with according to the principles already laid down.

V. Kocher's Method.—In **certain cases of extensive carcinoma,** and always when the disease involves the lower jaw, Kocher advises the following operation:

FIG. 135.

Step 1.—Put the patient in Trendelenburg's position. Pass a stout thread through the tongue for purposes of traction.

Step 2.—Beginning immediately below the symphysis of the lower jaw, make an incision downwards to a point a little above the hyoid bone; from here cut backwards to the anterior margin of the sternomastoid. Once more change the direction of the incision and continue it upwards along the margin of the sternomastoid to a point near the level of the lobe of the ear (Fig. 135).

Step 3.—Reflect upwards the skin-flap thus outlined.

Step 4.—Excise, *en masse* if possible, all the enlarged glands under the upper end of the sternomastoid and under the angle and horizontal ramus of the jaw. Carefully dissect free the anterior border of the sternomastoid, exposing the carotid packet of vessels and the great horn of the hyoid. Excise the glands in this region.

Step 5.—If the cancer affects the floor of the mouth, the fauces, or jaw, it is wise to ligate the facial vein and the external carotid artery.

Step 6.—Expose clearly the anterior belly of the digastric through its whole length, and ligate the veins under it. From

below upwards dissect free the packet of glands exposed until the entire posterior belly of the digastric and the stylohyoid muscles lie free in the posterior inferior part of the wound. Detach the mass of glands (lymphatic and salivary) from the lower jaw.

Step 7.—At the posterior end of the great horn of the hyoid divide the insertion of the hyoglossus muscle. This exposes the lingual artery. Tie the artery, but preserve the hypoglossal nerve.

Step 8.—The lower surface of the mylohyoid muscle now lies exposed and on it the mylohyoid nerve. At the posterior margin of the muscle penetrate the mouth (guided by a finger in the mouth) after once more noting the extent and limits of the disease. Beginning at this opening, divide the oral mucous membrane along a line remote from the disease. Attend to hemostasis.

Step 9.—Divide the lingual muscles at the hyoid and remove all infiltrated tissue. It is easy to pull the tongue out through the wound as soon as the oral mucous membrane has been divided.

If a preliminary tracheotomy has been done, the entrances to the larynx should be packed with sterile gauze as soon as the pharynx is opened.

After-treatment.—Leave the lower part of the wound open so that the laryngeal pack may be changed frequently. Every time the dressings are changed (and this must be done very frequently) administer plenty of nutritious food by means of an esophageal tube. As long as the mechanism of deglutition is seriously disturbed keep the patient in more or less of the Trendelenburg position except when he stands or sits up. As long as deglutition is poor the patient must not lie horizontally; he must either sit up or lie with his head and shoulders low. The object of this care is, of course, to avoid pneumonia from the entrance of secretions into the air-passages.

The question as to whether the last-mentioned operation should or should not be preceded by a tracheotomy is much discussed. Kocher and Jacobson are strong advocates of this as a preliminary.

The advantages of tracheotomy are the possibility of easy anæsthetization; of plugging the pharynx with gauze, thus avoiding inspiration of blood, and of greater freedom in operating.

The opponents of preliminary tracheotomy believe that this operation, while decreasing the danger of pneumonia from inspiration of blood, yet makes the patient subject to a greater danger of contracting pneumonia from other causes. If tracheotomy is decided on, it should be performed several days before the tongue is attacked, to permit the patient to become accustomed to the new conditions of respiration before his powers are taxed by the very severe operation he is to undergo.

VI. Butlin's Method.*—(A) The disease does not involve the floor of the mouth.

Step 1.—By Whitehead's method or some modification thereof remove the local disease with three-quarters of an inch of apparently healthy tissues around it in every direction. Where the disease is on the border of the tongue, it is best to remove that half of the tongue to an inch behind the cancer.

After about nine days, when the patient is able to take plenty of liquid food, proceed to Step 2.

Step 2.—Make an incision along the anterior border of the sternomastoid from near the mastoid process to the sternoclavicular articulation. Make an incision from the *symphysis menti* to meet the previous incision, just above the thyroid cartilage. Reflect the two triangular flaps of skin thus outlined and expose the platysma myoides and fat of the anterior triangle of the neck.

Step 3.—Beginning *below*, expose the sternomastoid and retract it backwards. Expose the carotid packet of vessels, dissecting from below upwards, and separate from it every particle of fat, whether superficial or deep, anterior or posterior. Be careful to remove the fat between the parotid and the vessels. All this fat ought to be left attached to that of the rest of the anterior

* Butlin, "Op. Surg. Malign. Dis.," second ed.; "Brit. Med. Jour.," Feb. 11, 1905.

triangle, otherwise the operation is liable to be incomplete (Fig. 136). Working from the region of danger (carotid packet) and from below upwards, remove *en masse* all the fat in the anterior triangle and with it the submaxillary lymphatic gland, leaving the muscles quite bare. In the submental region complete the dissection by searching between the geniohyoid muscles, lest a gland be overlooked.

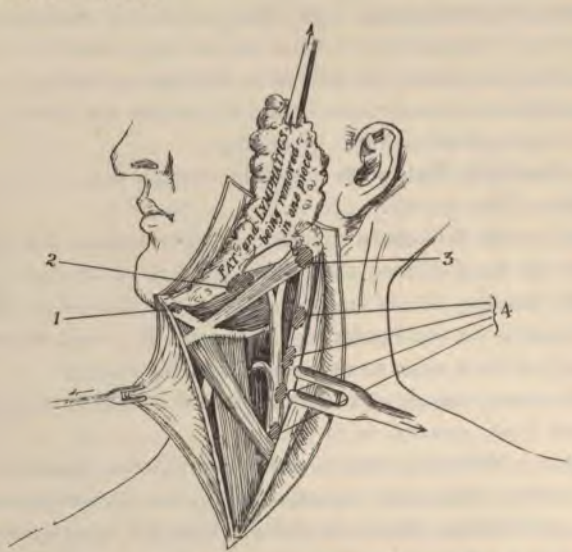


FIG. 136.—BUTLIN'S METHOD FOR EXCISION OF THE TONGUE.

Sketch indicating the position of the most important lymph nodes, all of which are supposed to have been dissected out and removed. 1. Location of submental group lymph nodes. 2. Location of submaxillary group lymph nodes. 3. Location of parotid group lymph nodes. 4. Location of carotid group lymph nodes.

If the disease involves the contents of the carotid packet, these must also be removed. The internal jugular vein more often requires removal than does the carotid artery.

Step 4.—Place one strip of gauze in the submaxillary triangle beneath the jaw and another between the parotid and the vessels. Bring the ends of the gauze out at the lowest part of the wound. Provide tubular drainage also. Close the wound. Damage to

the parotid will permit a leakage of saliva, but this ceases in a few days.

The principles of Butlin's operation are: (1) Operation in two stages is much safer than in one. (2) The glands are involved very early in lingual cancer, but the lymphatic vessels between the primary lesion and the secondary seem to escape.

(B) The disease involves the floor of the mouth to such an extent that the intrabuccal operation is impossible.

Remove the tongue by any of the methods already described, and according to the condition of the patient remove the glands of the neck either at the same or at a subsequent séance.

Whatever operation is chosen for removal of lingual cancer, it is always of prime importance to remove *en masse* the whole of the related lymphatic territory, even if the primary lesion appear trivial and the lymphatics show no macroscopic involvement.

When cancer is limited to the base of the tongue near the epiglottis, or when it affects the epiglottis, **Vallas' operation of transhyoid pharyngotomy** gives us good access to the parts. This operation is also suitable for the removal of foreign bodies and the treatment of syphilitic strictures. Preliminary tracheotomy is not essential.

The Operation.—Step 1.—Make a median incision through the skin and subcutaneous tissue from the symphysis of the lower jaw to the superior angle of the thyroid cartilage.

Step 2.—With blunt or sharp dissection separate, in the middle line, the fibres of the mylohyoid muscles, in such fashion as to expose the upper border of the hyoid bone in the median line.

Step 3.—With scissors or bone forceps divide the hyoid bone in the middle line. Retract the halves of the bone along with the fibres of the mylohyoid muscle. This gives us a space one and one-half inches in width.

Step 4.—The lower part of the wound is separated from the pharynx by the thyrohyoid membrane, the upper part by the mucosa. To reach the pharynx, divide the thyrohyoid membrane; to reach the base of the tongue or floor of the mouth, cut upwards.

Access has now been gained to the seat of the disease. It is unnecessary here to describe over again the removal of the neoplasm; it must be done freely on the principles already enunciated. Having completed the excision, close the wound, providing drainage at its lower end. No special suture of the hyoid bone is required.

CHAPTER XI.

PAROTID GLAND.

From the standpoint of operative surgery tumors of the parotid may be divided into two classes:

1. Those which are encapsulated inside the gland. This encapsulation may not be perfect, but there is no general infiltration of the gland by the disease. Such tumors are the adenomata and the mixed tumors of feeble malignancy.

2. Those tumors which infiltrate the gland substance. Such are the sarcomata and carcinomata.

The principles of operation which may be applied to both classes of tumor alike are: (*a*) Early operation; (*b*) free exposure of the growth by suitable incisions; (*c*) careful hemostasis.

When the tumor is one of those encapsulated within the gland, it should, if possible, be enucleated with its capsule, leaving the gland as little injured as is practicable. When the capsule cannot be removed with the growth, it should be removed afterwards as thoroughly as circumstances permit. The facial nerve must be preserved. An incomplete operation often gives good results, but completeness must always be the aim. When the tumor is of the infiltrating type, the *whole* gland with its fascial coverings or capsule must be removed, and with it any adherent skin. No attention may be given to the facial nerve; its destruction is certain. As in the case of cancers located elsewhere, too much rather than too little must be done. If the surgeon believes that the whole growth cannot be removed, it is better to abstain from operation. An incomplete operation is worse than useless.

I. Enucleation of Parotid Tumors.—(A) The tumor is small, mobile, and apparently easily removed: Make a horizontal incision over the most prominent portion of the growth, parallel

to the course of the fibres of the facial nerve and of length sufficient to permit of removal of the tumor under guidance of the eye and without bruising of the wound. Incise the gland substance so as to expose the tumor, which must now be shelled out. Attend to hemostasis; in doing this, suture-ligatures involving the gland substance should be avoided, as they are liable to constrict branches of the facial nerve and salivary ducts. Close the wound with or without drainage.

(B) The tumor is not large and not suitable for the simple procedure described above:

Step 1.—Beginning at the tip of the mastoid process, make an incision downwards along the anterior edge of the sternomastoid, to the level of the angle of the lower jaw; from this point cut forwards and upwards, in a curve, over the ascending ramus of the jaw, until a flap is outlined which when elevated will expose most of the tumor. The flap consists of skin and superficial fascia alone; no deeper structures must be involved because of the facial nerve.

Step 2.—The growth of the tumor inevitably pushes aside and spreads out the glandular tissue in which it lies. Examine the exposed surface for that part least covered by glandular tissue. The tumor capsule will generally be seen at once; if not, expose it by dividing *horizontally* any overlying glandular substance. If the capsule is strong, proceed to do an extracapsular enucleation by blunt dissection. Any bands of tissue passing to the capsule from its surroundings must be doubly ligated and divided. First free the anterior border of the tumor, then the posterior, and dissect free its deep surface *from below upwards* so as to gain early control of the vascular supply. Proceeding in this fashion, it is often possible to enucleate the tumor *en masse*, but often enough some deeply seated fragments are left behind; such must now be removed individually.

If the capsule is weak and the tumor soft, extracapsular enucleation is impossible. Under these circumstances freely incise the capsule, clean out its contents, and remove the capsule bit by bit as thoroughly as possible. This apparently very imperfect opera-

tion often gives excellent results. With regard to enchondromata of the salivary glands Jacobson writes: "It is not uncommon for branches of the facial nerve to be in relation with the capsule of the tumor, and if this has been much handled, or treated by counterirritation, they may very likely be firmly adherent. In either case injury to the nerve may be best avoided by slitting up the capsule and shelling out the enchondroma first. The capsule should then be examined to see if any nerve branches are adherent to it; after these have been separated, the capsule itself should be removed. This should always be done to prevent any recurrence, as the peripheral part of these enchondromata is often adherent to the capsule itself." ("Operations of Surg.," I, 340.)

Step 3.—Attend to hemostasis. Close the wound by sutures. Drain dead spaces. Dress.

FIG. 137.

II. Excision of the Parotid.—Excision of the parotid is necessary in cases of malignant neoplasms, such as carcinoma or sarcoma. As these tumors are infiltrating in character, enucleation is impossible and useless; the whole gland must be removed, whether evidently affected or not.

Step 1.—Make a ⊢ shaped incision (Fig. 137) of sufficient extent through the skin. Reflect the skin so as to expose all the parotid covered by its fascia.

Step 2.—Mobilize the anterior edge of the gland and tumor. Doubly ligate and divide the vessels situated here and Steno's duct. Forceps may be used instead of ligatures during the dissection. Separate the gland from the masseter, working from before backwards, doubly ligating all vessels before dividing them.

Step 3.—Separate the lower edge of the gland (submaxillary portion) form its surroundings by blunt dissection, doubly ligating and dividing the vessels.

Step 4.—Expose the upper end of the anterior portion of the

sternomastoid, open its sheath, and retract the muscle backwards. That portion of the sheath adherent to the fascia covering the parotid must be removed with the tumor.

Step 5.—By blunt dissection, working from below upwards and elevating the lower edge of the gland, expose the external carotid artery as it passes under the stylohyoid and digastric muscles. Doubly tie and divide the artery. Mobilize the tumor and gland up to the level of the styloid process.

Step 6.—Separate by blunt dissection all connections between the tumor and the temporo-maxillary joint. Ligate and divide the temporal vessels at the level of the zygoma.

Step 7.—Pull the gland, etc., backwards, expose the numerous veins which run, along with the internal maxillary artery, from behind the neck of the lower jaw into the gland. Doubly ligate this leash of vessels and divide them.

Step 8.—Separate by blunt dissection the posterior and pharyngeal connections of the gland, doubly ligating or clamping all vessels before dividing them. In making this last dissection be on the lookout for and avoid injury to the internal jugular vein.

Step 9.—Attend to hemostasis. Close the wound with sutures after providing for drainage.

Any enlarged lymphatic glands near the parotid ought to be removed along with the tumor. The operation is a difficult one, and ought not to be attempted by the inexperienced.

Salivary Fistula.—A salivary fistula most commonly results from disease or injury of Steno's duct. In some cases a stricture is present distal to the fistula, and if this is dilated, the fistula either closes spontaneously or after its orifice has been stimulated by the cautery or revivified and sutured. When the above simple treatment is inappropriate or has failed, operation becomes necessary.

I. The fistula is anterior to the masseter muscle.

(A) *von Langenbeck's Operation.*—Make the proximal portion of the duct (*i. e.*, the segment of duct next to the parotid gland) prominent by passing a probe into it, through the fistula. With a knife or scissors separate the fistula and duct from their sur-

roundings, leaving them attached to the gland. In a convenient location pass the knife from the wound into the mouth, perforating the buccal mucosa. Pull the free end of the mobilized duct into the mouth through the perforation in the mucosa and fix it there with sutures. Close the external wound. When applicable, the above is the best operation for salivary fistula, but unfortunately it is not often available, as the unnatural orifice is usually far back near the origin of Steno's duct behind the anterior margin of the masseter.

(B) *Deguise's Operation.*—From the fistula make two perforations into the mouth, about ¼ inch apart. Through these openings pass the two ends of an elastic ligature, a piece of lead

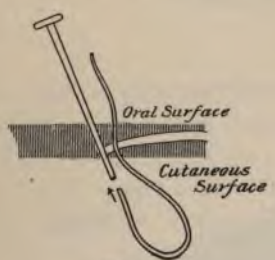


FIG. 138.

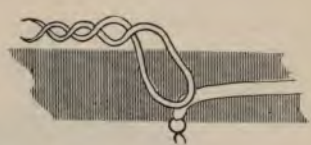


FIG. 139

wire, or a stout silk suture. Fasten together the ends of the ligature in the mouth so as to exercise pressure on the included tissues. Necrosis of the tissues follows and a permanent opening into the mouth is assured. Freshen the edges of the cutaneous fistula and unite them by sutures. The elastic ligature or lead wire may best be introduced through a cannula which is made to perforate the cheek from within outwards (Figs. 138, 139). A silk suture is best inserted from without inwards by means of a needle at each end.

(C) *Kaufmann's Operation.*—Pass a cannula (about ⅛ inch in diameter) from the fistula into the mouth and through it introduce a rubber tube or seton. Remove the cannula, leaving the seton in place. Whenever the track of the seton has become

covered with epithelium, remove the seton and close the cutaneous orifice of the fistula.

II. The fistula is situated in the masseteric portion of Steno's duct.

(A) Either Kaufmann's seton or Deguise's method of double puncture may be used, but neither the seton nor the constricting ligature must perforate the masseter. The puncture or punctures

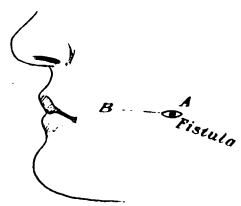


FIG. 140.

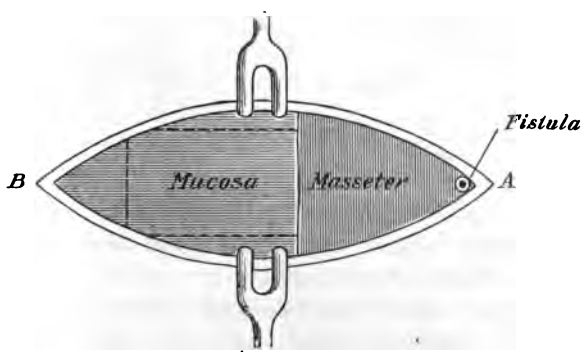


FIG. 141.

must pass from the fistula to the mouth by tunnelling between the masseter and the skin.

(B) von Langenbeck's method may be used if a sufficient length of duct remains attached to the gland. In this method it is necessary to puncture the masseter and pull the mobilized portion of duct through the puncture into the mouth. Instead of being punctured, the masseter may be divided transversely,

and if necessary a portion of the ascending ramus of the lower jaw may be cut away with rongeurs so that the defective duct may gain access to the mouth.

(C) Plastic formation of a new duct (Braun's operation): Make the incision A, B (Fig. 140). Mobilize the fistulous orifice by dissecting it free from the skin. The incision penetrates all the tissues of the cheek except the mucosa and masseter. Retract

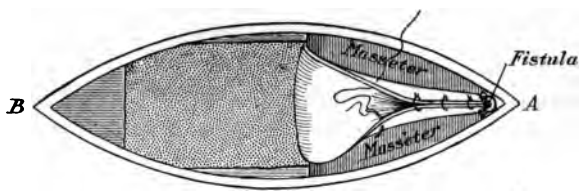


FIG. 142.

the edges of the wound, exposing the outer surface of the mucosa (Fig. 141). From the mucosa construct a flap with its pedicle at the edge of the masseter, of length sufficient to reach from the masseteric edge to the fistula. Turn this flap back over the masseter; suture its free end to the fistula; suture its upper and lower edges together so as to form a tube lined with epithelium (Fig. 142). Close the skin-wound.

CHAPTER XII.

RHINOPLASTY.

Rhinoplasty, or the reconstruction of the nose, is called for in cases where the nose has been destroyed by disease or operation. As the destruction may be limited or extensive, so the operation may be partial or complete.

COMPLETE RHINOPLASTY.

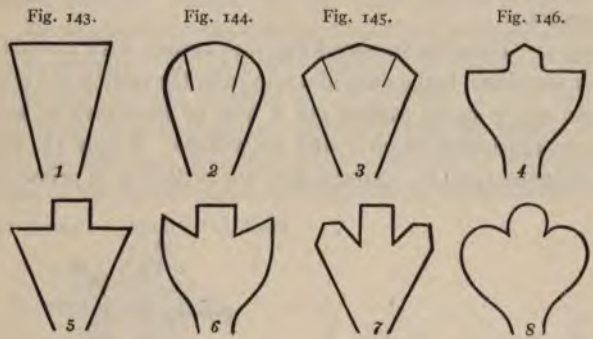
I. The soft structures of the nose have been destroyed, but the osseous and cartilaginous framework remains; the object of the operation is to replace the soft parts in as natural a manner as possible.

(A) **Indian Method.**—In this operation a pedunculated flap is taken from the forehead and sutured to the nasal defect.

The Operation.—With oiled silk make a model of the flap required. Figures 143 to 150 represent variously shaped flaps which have been used.

Step 1.—Place the anæsthetized patient in the Rose or Trendelenburg posture. Thoroughly freshen the edges of the nasal defect down to, but not beyond, the points into which the new alæ of the nose are to be inserted. Freshen the point into which the new nasal septum is to be inserted. When considerable skin exists over the bridge of the nose, Step 1 may be modified advantageously as follows: From the nasal bridge reflect the flap of skin A B C (Fig. 152) and turn it down with its epidermal surface directed towards the nasal cavity. Freshen or pare the edges of the nasal defect as already described. When in Step 3 the forehead flap is turned down, its raw surface lies in contact with the raw surface

of the flap from the nasal bridge, an epidermal lining is provided for the new nose, and thus shrinking is obviated.



FIGS. 143 TO 150.—(*Esmarch and Kowalzig.*)

FIG. 151.—(*Esmarch and Kowalzig.*)

FIG. 152.

Step 2.—Place the oiled silk model on to the forehead, in an oblique position and with its pedicle so placed as to include the angular artery. Guided by the model as to shape and size, cut

a flap from the forehead. The flap consists of all the structures down to the bone. With sutures lessen the size of the defect left in the forehead; cover such open wound as may be left with skin-grafts.

Step 3.—Turn the forehead flap downwards with its epidermal surface forwards, being careful not to twist the pedicle too severely. As this step is being carried out it may be necessary to lengthen the lateral incisions which bound the pedicle. Figure 151 shows a well-designed pedicle. Attention to the pedicle is of prime impor-

FIG. 153.

FIG. 154.—(*Esmarch and Kowalzig.*)

tance because too great torsion means interference with the blood-supply, and more particularly with the drainage of the flap. It is wise to make numerous shallow scratches through the epidermis of the flap; these permit of lymphatic drainage. (See chapter on Plastic Operations.) Fold on itself, laterally, that portion of the flap which is to form the new septum of the nares and maintain this fold by one or two stitches (Fig. 153). Fold on themselves the two lower angles of the flap which are to form the alæ of the nose and maintain the folds by means of mattress sutures.

Step 4.—Suture the raw edges of the new alæ of the nose into their proper position in the nasal defect. Do the same with the new nasal septum. Suture the rest of the flap in position (Fig. 154). Do *not* use too many sutures near the pedicle, and in attempts at esthetic effect do not jeopardize the vitality of the flap, which depends on the freedom of the pedicle. If the flap lives and unites in its new position, any defects in the appearance of the root of the nose may be safely attended to subsequently. Keep the newly formed nasal openings patent by means of dressed rubber tubes or cigarette drains.

Fig. 155.

Fig. 156.

FIGS. 155 AND 156.—(*Monod and Vanverts.*)

(B) French Method.—In this operation pedunculated flaps taken from the cheeks are used to repair the nasal defect. Figures 155 and 156 sufficiently describe the operation as performed by Nélaton.

(C) Italian Method.—Skin for the repair of the nasal defect is obtained from the anterior and inner aspects of the upper arm.

Step 1.—Dissect from the upper arm a flap of skin, with its pedicle pointing towards the elbow. Flex the shoulder, and bring the free end of the flap in contact with the vivified edges of the nasal defect. Unite the flap to the nasal defect by means of sutures. With a suitable apparatus (Fig. 157) fix the head and

arm so that they maintain a constant relationship to each other until union has taken place.

Step 2.—When the flap is firmly united to the edges of the nasal defect, divide its pedicle and complete the rhinoplasty by forming the alæ and septum of the nose out of the lower portion of the flap.

This Italian method is exceedingly cumbersome, and few patients would endure the suffering incident to its completion.

II. The soft structures and the osseous and cartilaginous

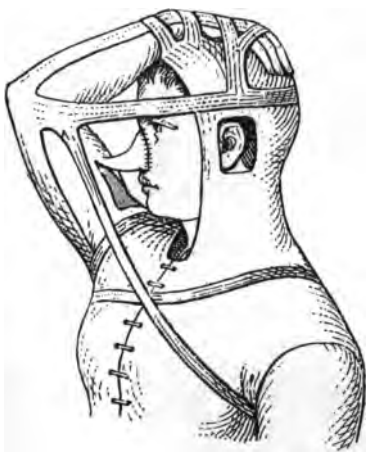


FIG. 157.—(*Monod and Vanverts.*)

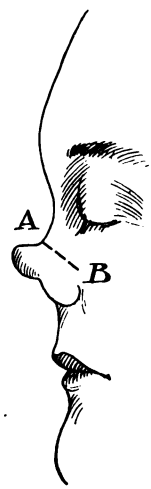


FIG. 158.

supports of the nose have been destroyed. The tip of the nose with its alæ and septum may or may not be left intact.

(A) König's Operation.—This operation was originally devised for the correction of saddle-nose, but it is also of great value in the treatment of cases where the soft parts are absent as well as the hard. The operation as here described is that done for saddle-nose; the modifications required when the soft parts are absent are so self-evident that they will not be mentioned.

Step 1.—Make a transverse incision across the seat of the saddle (A, B, Fig. 158). Pull the tip of the nose down into correct position.

Step 2.—From the forehead turn down the vertical flap D (Figs. 159 and 160) and suture its free extremity to the point C, at the tip of the nose. This flap is ½ inch wide and is made by cutting through the soft parts with a knife, introducing a narrow chisel through the upper part of the wound, and thus elevating a long narrow strip consisting of skin, periosteum, *and* the outer

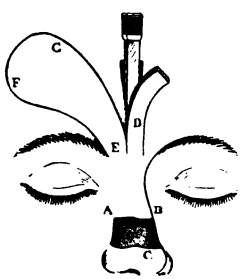


FIG. 159.

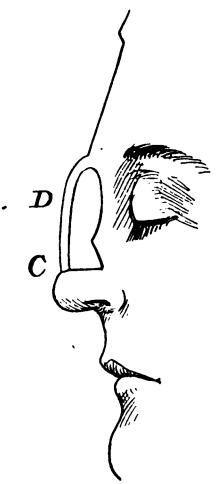


FIG. 160.

table of the skull. The bone in the flap gives firmness to the new nose.

Step 3.—After the Indian fashion, reflect, from the forehead, a skin-flap, E, F, G (Fig. 159), and turn it down so as to cover the nasal defect A, B, C (Figs. 159 and 161), as well as the flap D.

The results obtained from this operation or some of its modifications have been very satisfactory.

(B) Israel's Operation.—This is merely a modification of the preceding method, but gives better cosmetic results. The

flap D (Fig. 160) is made narrow, being only about ⅛ inch wide, and when turned down and its free end sutured in place, exactly as in König's operation, it is left uncovered by any other flap. After a short time the raw surface of the flap becomes covered by granulation tissue and the epidermis spreads over it. The local condition is now the following: The tip of the nose is in normal position. The skin and bone flap D (Fig. 160) bridges over the defect created by the incision A, B (Fig. 158), and also the undivided skin at the root of the nose. Whenever the flap D has become well healed, draw it slightly to one side; make a

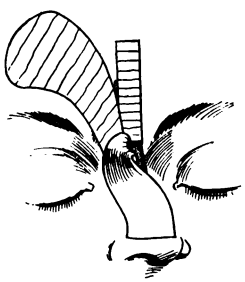


FIG. 161.

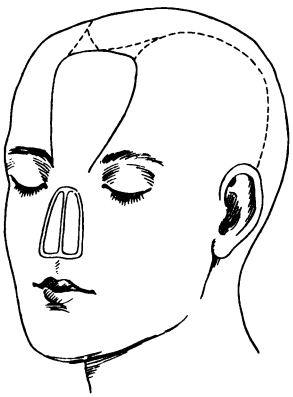


FIG. 162.

vertical median incision through the skin at the root of the nose above the defect. Elevate this skin on each side of the median incision, bring the edges up, and suture them to the vivified edges of the new nasal bridge (flap D, Fig. 160).

(C) **Schimmelbusch's Operation.**—Practically as in the Indian method, make a forehead flap to cover the defect in the nose, *but* here the flap consists of the outer table of the skull as well as skin (Fig. 162). Protect the flap with gauze and close the forehead defect, preferably by sliding forwards and inwards large flaps of the scalp, as shown in figures 162 and 163. Examine the reflected flap of bone and skin. If the bone is not splintered,

cover the whole raw surface at once with Thiersch's grafts, protect the grafts with silver-foil or rubber tissue, and apply gauze dressings. With bandages support the flap against the head and wait until the grafts have become mature. This period of waiting is of value in that the flap becomes accustomed to receiving its nourishment through the pedicle before the pedicle is disturbed by twisting, but as the flap inevitably shrinks during the delay, it is very necessary that it be made *at least* one-sixth larger than the defect to be filled. If on examination the bone in the flap is found to be splintered, delay the skin-grafting until any necrotic bone is thrown off and the remainder is covered by granulations

FIG. 163.

FIG. 164.

(four to eight weeks). When the raw surface of the flap is satisfactorily covered with epidermis, make an incision with a fine saw in the middle line through the bone in the flap, so that the flap can now be bent into a $\wedge$ shape (Fig. 163). Mobilize the pedicle of the flap and twist the latter into position. With sutures unite the edges of the flap to the freshened edges of the nasal defect. When freshening the edges of the nasal defect, it is easy to form flaps of tissue which may be used to form a septum for the nostril (Fig. 164).

(D) Nélaton's Operation.—Ch. Nélaton has devised an ingenious method of rhinoplasty which requires no description other than that afforded by Figs. 165, 166, 167, 168.

of a proper collar. After healing has taken place, massage, exercises, and, for a time, the use of some orthopedic apparatus, such as Sayre's, are requisite.

Myomectomy.—*Mikulicz's Operation.*—In severe cases of torticollis Mikulicz advises excision of the lower two-thirds of the sternomastoid, the upper one-third being preserved so as to avoid injury to the spinal accessory nerve.

Expose and divide the sternal and clavicular portions of the muscle as in open tenotomy. Seize the divided ends in forceps and pull the muscle downwards and through the skin-wound; as this is done, separate it from its surroundings by blunt and sharp dissection. Avoid injuring the external jugular vein. When two-thirds of the muscle is isolated, divide and remove it. Attend to hemostasis. Divide all cicatricial bands which can be felt. Close the wound. Apply dressings and pressure enough to obviate dead spaces. No subsequent orthopedic treatment is required.

Bruns in doing this operation removes only one-third of the muscle. The chief disadvantage of the operation is cosmetic, viz., the loss of the shapeliness of the neck. It should be reserved for severe or recurrent cases.

Division of Spinal Accessory Nerve.—The spinal accessory nerve escapes from the skull through the jugular foramen. It runs obliquely downwards and backwards between the internal jugular vein and the digastric muscle, entering the sternomastoid muscle at a point about two inches below the mastoid process. The nerve pierces the muscle obliquely and proceeds across the posterior triangle of the neck to supply the trapezius.

The Operation.—Make an incision 2½ to 3 inches in length from the mastoid process downwards along the anterior border of the sternomastoid. Expose the anterior border of the muscle and divide the cervical fascia. Retract the muscle backwards. With the finger recognize the transverse process of the atlas, which is covered by the digastric muscle. The nerve, after passing between the bony process and the muscle, emerges at the

lower edge of the latter and passes to the sternomastoid. Expose the nerve and either divide it or excise about one-half inch of it. Close the wound with sutures. Dress. The results of the operation are usually good; the danger is practically *nil.*

Multiple Myotomy.—*Kocher's Operation.*—Two incisions are necessary.

1. Make an incision 1¼ to 1½ inches in length along the anterior border of the sternomastoid, commencing opposite the angle of the jaw and passing upwards. Divide the platysma and if possible save the external jugular vein. Open the sheath of the sternomastoid along its anterior border. Introduce a blunt dissector under the muscle and divide it layer by layer. Attend to hemostasis. Close the wound with sutures. If desired, the spinal accessory nerve may be stretched or divided during this procedure.

2. The patient is turned on to his sound side. Beginning at the mastoid, make a transverse incision backwards. Through this divide the trapezius transversely and incise the splenius capitis and complexus muscles. Avoid injuring the great occipital nerve, which here traverses the complexus and trapezius. The inferior oblique muscle arises from the spinous process of the axis and is inserted into the transverse process of the atlas. Look for this muscle in the space between the atlas and axis and divide it. Attend to hemostasis. Close the wound.

Monod and Vanverts write as follows: "Section should be made of the muscles which participate in the spasm. It is necessary, by analysis, to determine prior to operation the muscles involved. One may be compelled to practise, according to the case, the following operations: division of sternomastoid and of the muscles of the nape of the neck on the opposite side (typical rotary tic); division of the sternomastoid and of the muscles of the nape of the neck on the same side (rotary tic with predominance of lateral deviation); division of sternomastoid and bilateral division of the muscles of the nape of the neck (rotary tic with much posterior extension)."

Remarks.—In some cases of torticollis no operation seems to be effectual; such are usually due to affections of the posterior nerve and muscle groups. Extirpation of the nerves involved

has been advised, but this is a very complicated, and for most surgeons inadvisable, operation, and is not a glittering success.

In other cases any operation involving tenotomy is successful. When the muscle is greatly degenerated and adherent, Mikulicz's procedure is the best. In spasmodic varieties of torticollis section of the spinal accessory nerve is the operation of choice.

CHAPTER XIV.

EXCISION OF CERVICAL TUMORS.

The various operations for the removal of cervical tumors, if at all extensive, should never be undertaken by a tyro in surgery. These operations are very dangerous in the hands of one who is not possessed of a good working knowledge of anatomy, especially of the anatomy of the living, and of wide surgical experience.

A good type of the operations under discussion is the removal of tuberculous glands. Ideally, when the disease is extensive, one should endeavor to remove all the cervical glands and their lymphatic connections in one piece. This is, of course, impossible; but it is a good plan for the surgeon to try to approximate the ideal, even although he knows that his endeavors to do so will fall far short.

What are the dangers of the operation?

1. **Hemorrhage.**—If care is taken, bleeding need cause little anxiety. The precautions taken to avoid air embolism will certainly have the effect of preventing much hemorrhage.

2. **Air Embolism.**—During inspiration, the blood in the cervical veins is under negative pressure. If under these circumstances the vein is wounded, air is liable to be sucked into it and thus into the heart—a very fatal accident. Careful attendance to the principles of technique for cervical operations will obviate most of the danger.

(*a*) The wound through the skin and fascia should be large enough to give free access to every part to be operated upon.

(*b*) The wound should be kept moist, and if the slightest "hissing" sound be heard in the wound, the finger should press the tissues at a point nearer the heart than where the wounded

vein is. The "hissing" signifies entrance of air. The digital pressure is meant to hinder the passage of the air towards the heart. At the same time as the finger pressure is applied, a spongeful of water must be squeezed into the wound. This effectually prevents more air getting in. The wound in the vessel must be caught by pressure forceps. J. B. Murphy places a small pack of gauze, with a thread attached to keep it from being lost, under the sternal attachment of the sternomastoid muscle. The pressure of the pack keeps the cervical veins full, prevents the danger of negative pressure, and makes the veins very visible. This expedient is of great value; the trifling increase in hemorrhage is of no importance. When "hissing" in the wound occurs and makes one suspect air embolism, remember that it may be due to the pleura being accidentally opened —a very fatal accident. The pleura extends an inch or more above the first rib.

(*c*) No more cutting should be done than is absolutely necessary. Blunt dissection is most meritorious.

(*d*) *Never* cut in the dark or without full knowledge of the safety of what is being divided.

(*e*) Bleeding points are at once caught by pressure forceps. If it is suspected that forcipressure kept up for a few minutes will be insufficient to stop the bleeding, the vessel should be secured by a fine ligature.

(*f*) In removing the glands no forcible tearing should be perpetrated. Veins are often very friable.

(*g*) Structures about to be cut ought *not* to be on tension. Tension empties veins and makes them look like bands of fibrous tissue.

(*h*) When in the *slightest* doubt as to the contents of a strand of tissue which must be severed, apply two forceps or two ligatures and cut between.

When, in spite of all precautions, air has been sucked into a vein, fill the cervical wound loosely with wet gauze; do not apply forceps to the vein; during the succeeding expirations forcibly compress the chest; do *not* lower the head and shoulders of the patient.

3. When operating low down in the neck on the left side, **avoid injuring the thoracic duct.** Such injury is not uncommon. If noticed at the time, one sees a little clear fluid escaping. Compression sutures in the vicinity of the injured duct *plus* gauze packing usually leads to recovery, but fluid escapes, in spite of treatment, for about two weeks, and there is great emaciation. The injury generally heals in about three weeks or less. P. Lecène thoroughly discusses this accident. ("Revue de Chir.," Dec., 1904.)

4. **Injury to Important Nerves.**—The danger of injuring important nerves in the neck is by no means great. The vagus is well protected, lying in the carotid sheath. If care be taken, the spinal accessory nerve can usually be recognized and often preserved; its preservation is of much greater importance in the young than in the mature. Injury to the phrenic and the recurrent laryngeal nerves is extremely rare. Injury to the cervical sympathetic system seems to produce no ill results.

The Operation.—In slight cases where the glands are neither numerous nor adherent the operation is extremely simple. An incision is made over the swelling, and through this the tumors are easily shelled out. The method of operating about to be described is for extensive and complicated disease.

The patient lies on his back with the shoulders supported and the head turned towards the side. The scalp should be covered by a well-fitted gauze or rubber cap, to keep the hair out of the way. An oblique incision is made along the sternomastoid muscle from the mastoid process to near the sternoclavicular articulation. The external jugular vein is exposed and divided between two ligatures. The skin anterior and posterior to the incision is dissected from the subjacent tissues and retracted. If necessary, a second cut may be made parallel to and near the clavicle, from the lower end of the oblique incision outwards. Another incision, and one which leaves little noticeable scar, follows the margin of the vertical hair line of the back of the neck; to this cut is joined one following the clavicle forwards (Fig. 182). Expose the sternomastoid and free it from its surroundings

throughout its whole length. Notice the point of emergence of the superficial cervical nerves at the posterior edge of the muscle; the nerves are not small, and here the muscle is more firmly attached to its surroundings than elsewhere, hence this point constitutes an anatomic landmark (Fig. 183). One-half inch above this landmark the spinal accessory nerve emerges from the sternomastoid muscle and is easily found. The nerve enters the muscle about two inches below the tip of the mastoid process, after passing over the prominent transverse process of the atlas. In cases of tuberculosis it is commonly easy to trace the nerve in its course to the trapezius and to separate it from the diseased structures. In the young it is important to preserve the nerve,

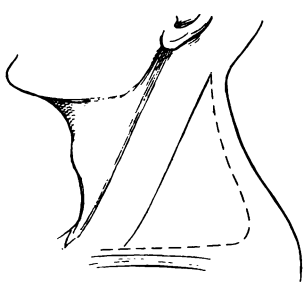
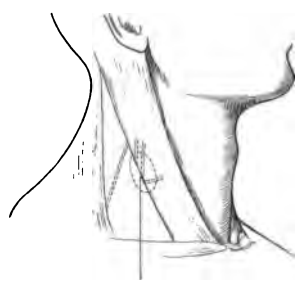


FIG. 182.



Superficial cervical nerves.
FIG. 183.

because Fenger has shown that its division leads to drooping of the shoulder and to scoliosis.

The packet of fascia which contains the carotid artery, internal jugular vein, and the vagus must now be exposed. Once exposed, the protection of these extremely important structures becomes more or less easy. Up to this time no attempt has been made to remove diseased tissues. The disease is now attacked. Beginning near the lower end of the wound and by the side of the carotid packet, the removal of the diseased glands with the gland-bearing fascia is generally a comparatively easy matter, and can be carried out systematically. If the important anatomical structures are not exposed and protected at an early stage in the

operation, systematic, thorough removal of the glands is very difficult and dangerous. The diseased structures having been removed and all hemorrhage stopped, carefully suture the wound in the cervical fascia, preferably with catgut. Suture of the fascia most notably removes tension from the skin-wound. If the fascia is not well united, the skin-wound is liable to stretch and give rise to a wide, ugly scar. Provide drainage at the lower angle of the wound. Close the skin-wound neatly, using intradermic sutures or ordinary sutures, preferably of horse-hair. Horse-hair sutures, being elastic, leave less scar than sutures of any other material. After operations on the neck very extensive dressings are required, as small dressings are difficult to keep in place.

In the course of any operation for the removal of tuberculous glands some of them may be ruptured and from them there escapes caseous material. Such extravasated matter must be carefully washed away, and it is good practice to scrape the remnants of the caseated material from the ruptured gland, subsequently mopping the part scraped with liquid carbolic acid, followed by the application of alcohol to neutralize the carbolic. When glands are so firmly united to the great vessels of the neck that their removal is very risky, it is proper to remove as much of the gland as possible and sterilize the remainder with liquid carbolic, afterwards neutralizing with alcohol.

Subcutaneous Removal of Tuberculous Glands in the Neck and Submaxillary Regions (Dollinger's Operation).— The operator sits behind the head of the patient and wears an electric headlight. An assistant holds the patient's head free and moves it to suit the convenience of the operator. Beginning near the external auditory meatus, make an incision, $2\frac{1}{2}$ to 3 inches in length, downwards and backwards, parallel to and about $\frac{1}{3}$ inch from the margin of the hair. Through this incision packets of glands in almost all the cervical region may be reached and removed by blunt dissection, the surgeon undermining the skin to a point below the packet to be removed and removing the glands from below upwards. Nerves and vessels must be pushed

aside. When the glands are seized with forceps, they often tear or collapse, especially if they are caseated. This accident, according to Dollinger, does no harm, provided the débris is promptly washed away. Cases in which periadenitis has caused the formation of many firm adhesions are unsuitable for this operation. After removal of the glands the whole wound must be reviewed, cleaned, drained, and sutured. The hemorrhage is remarkably slight.

The location of particular groups or packets of glands is as follows:

I. The retroauricular and subauricular glands lie next to the incision and are easily removed.

II. The preauricular glands lie on the parotid beneath the masseteric fascia, which they penetrate and so reach the subcutaneous tissues. To reach them pass under the external auditory meatus. The facial nerve is not in danger.

III. The glands under the head of the sternomastoid lie posterior to the accessory nerve, which must be carefully preserved. Glands also lie in front of and beneath the nerve and must be removed with great care. One reaches these glands from the wound by dissecting under the posterior edge of the sternomastoid.

IV. Glands in the vicinity of the lower end of the parotid gland and of the posterior facial vein are reached by burrowing between the skin and the sternomastoid. When the disease is of long standing, the posterior facial vein is often obliterated. Preserve the external jugular vein and the great auricular nerves.

V. Glands about the submaxillary lymphatic glands. These are usually three in number and lie between the salivary gland and the lower jaw. One next burrows between the skin and the sternomastoid to the group of glands anterior to the muscle, and illuminating the wound with the headlight, opens their fascial covering and removes them bluntly.

VI. The submental glands, two in number, lie between the anterior bellies of the digastric. These are best removed through a small incision directly over them.

VII. Glands in the lateral triangle of the neck number about 50. The upper ones can be easily reached through the primary incision. The lower ones lying in loose connective tissue are easily pushed upwards and extirpated. Look out for and preserve the branch of the spinal accessory going to the trapezius, the cervical and the brachial plexus. These structures are separated from the glands by a layer of cervical fascia. The external jugular vein is often obliterated.

VIII. The deep cervical glands lie along the great vessels under the sternomastoid, and can be reached by undermining the muscle. If the glands are firmly united to the vessels, pull them to the surface with a sharp hook and carefully dissect them free. Remember that the traction empties the internal jugular vein and makes it look like an innocent band of tissue.

This proceeding seems to the author very hazardous. Dollinger's operation seems to be excessively difficult, and may easily be very incomplete, but that surgeon has performed it in very many cases, and with excellent results. [Dollinger's description of his operation appears in the "Proceedings of the German Surgical Society," 1903.]

When the disease for which operation is required is malignant, almost everything holds good which has been said regarding the excision of tuberculous glands, but the work is more complicated and difficult. That malignant disease should be excised as thoroughly as possible is as true in the neck as elsewhere, but thoroughness is more difficult to attain in this region. The incision made must vary according to circumstances. It may be obliquely vertical, transverse, or a horseshoe-shaped flap with its pedicle upwards or downwards may be dissected from over the tumor. When the growth is exposed, it must be separated from its surroundings. In doing this it is usually wise to attend to the most dangerous parts first. Thus, when feasible, the surgeon should begin the enucleation at the point nearest the large vessels, so that in case of accident or difficulty these may be under control. If the carotid artery or the internal jugular

vein passes into or becomes inseparably united to the tumor, it is well to know the trouble early in the operation so that one may intelligently make up his mind as to the propriety of braving the dangers of a completed operation or the advisability of closing the wound before it is too late to recede.

The carotid artery lies deeper than the vein and is rarely involved in the disease. The vein is often infiltrated or surrounded by the tumor and requires ligation or removal, which is not particularly dangerous. Ligation of the common carotid has a mortality of about 26 per cent. (from cerebral softening principally). In operations for malignant disease Crile applies his clamp (Fig. 184) to the artery and thus temporarily controls it. Some surgeons throw a soft temporary ligature around the artery,

Fig. 184.

which serves the same purpose as Crile's clamp but does not do so in quite as elegant a fashion. Temporary control of the carotid is of great value in operations for malignant neoplasms.

If it seems probable that the tumor may be dissected free from the vessels, it is often proper to lay a ligature loosely in position around the internal jugular vein (to the cardiac side of the growth) so that, should air embolism be seriously threatened during the later stages of the operation, an assistant can quickly tighten the thread and avert danger.

Note.—In connection with severe surgical operations on the neck it should be distinctly understood that section of the vagus nerve is not necessarily fatal. Giordano (quoted in "Annals of Surg.," June, 1894) finds that after maltreatment of the nerve in surgical cases the mortality is not higher than 45 per cent., while in resection it is 75 per cent. Crile ("Problems Relative to Surgical Operations," 1901) has made numerous experiments on the vagus and reports a number of cases in which the vagus of one side was excised without ill effect. Before operations in which the vagus may be irritated or divided he finds it wise to administer $\frac{1}{100}$ grain of atropin in order to prevent any cardiac or respiratory inhibition.

Hydrocele of the Neck; Cystic Lymphangioma.—A hydrocele of the neck consists of a monolocular or multilocular cyst which may extend into the anterior mediastinum or deep down among the large vessels of the neck. The disease is congenital. Of course, the ideal treatment is extirpation, but this is rarely proper because of its difficulty and danger. If extirpation is decided on, the operation ought to be delayed until the end of the first year of life (Arrou). The most common operative treatment consists in evacuation by trocar and cannula, followed by irrigation with a 2 per cent. solution of carbolic acid, or by injection of tincture of iodine diluted with water. This simple treatment often gives excellent results; it is liable to fail when there are many compartments or loculi in the cyst. When evacuation and injection fail or are inappropriate, marsupialization affords a means of treatment which is thorough and is safer than extirpation. Marsupialization consists in incising the cyst; suturing the edges of the wound in the cyst to the skin; opening the subsidiary cyst cavities; evacuating all the contents and providing for drainage by means of a gauze tampon. In the course of the operation part of the cyst-wall may be removed and the interior of the cavity may be swabbed first with liquid carbolic acid and then with alcohol to neutralize the carbolic.

Congenital cervical fistulæ require radical treatment when they give rise to much inflammation or to cystic tumors; esthetic considerations may call for their removal. Occasionally the fistulæ are shallow and their extirpation is then easy. Usually they are complete, reaching from the neighborhood of the tonsil (Rosenmüller's fossa behind the tonsil), passing under the digastric muscle to penetrate the cervical fascia and the skin in almost any location between the sternomastoid muscles. Such fistulæ must be *completely* excised, otherwise recurrence is liable to take place. The skin-incision must be extensive and the cord-like fistulous track followed (preferably without being opened), under guidance of the eye, up to its pharyngeal termination. This dissection is not one for the tyro in surgery to attempt. The removal of the pharyngeal end and closure of the pharyngeal wound are most

difficult, but this difficulty has been evaded in a most ingenious manner by Fritz König. After the fistula has been mobilized to a point above the digastric muscle, König separates it still further from its surroundings by blunt dissection until the pharyngeal mucous membrane is nearly reached; then he opens the mouth with a Whitehead speculum, passes a stout probe with an eye on the proximal end through the wound, and makes its point appear elevating the mucous membrane in front of the lower margin of the tonsil. An incision made through the mouth over the end of the probe permits the latter to be pulled through, and with it a thread of silk. The end of the fistula, after being tied to the thread, is easily pulled into the mouth, fastened by a couple of stitches to the wound in the mucosa, and its free end cut away. The external wound is now closed. Instead of a long fistula leading from the pharynx to the skin, there is a short, harmless fistula leading from the back to the front of the tonsil. This simple "dodge" of König's is one of great value.

When operating on cervical cysts it is well to remember that such are often merely dilated portions of more or less obliterated cervical fistulæ, and that unless the fistulæ are recognized and extirpated, recurrence is liable to occur.

Median cervical fistulæ are different from those alluded to above; they are the result of non-obliteration of the thyroglossal duct. The thyroglossal duct leads from the foramen cæcum on the tongue through the root of that organ down to a low point in the neck. On its way down the duct either passes through or is closely connected with the body of the hyoid bone. Excision of a patent or inflamed duct below the hyoid is easy; above that bone, it may be difficult or easy, generally the former. If the duct passes through the hyoid, the portion enclosed in the bone must be thoroughly removed even if it is necessary to excise a portion of the bone itself. Occasionally that part of the duct which traverses the tongue gives rise to a tumor consisting of tissue very like that of the thyroid gland. Such tumors are usually easily shelled out of the tongue. Cysts arising from distention of the duct above the hyoid may give rise to ranula-like

tumors. In treatment of ranula it is well to bear this fact in mind. A stubborn and obscure recurrent phlegmonous inflammation in the submental region may be due to an unsuspected remnant of the thyroglossal duct.

CHAPTER XV.

EXCISION OF THE CERVICAL SYMPATHETIC.

Jonnesco describes the total excision of the cervical sympathetic very nearly as follows:

Step 1.—*Cutaneous incision:* Make a cut from behind the mastoid process downwards along the posterior border of the sternomastoid to a point a little below the clavicle. The external jugular vein is divided between two ligatures.

Step 2.—*Separation of the posterior border of the sternomastoid:* To avoid section of the external branch of the spinal accessory nerves and the difficulties often met in freeing the posterior border of the muscle in the upper part of the wound, make an incision along the muscle parallel and close to the posterior margin. Separate the fibres of the muscle and operate through this elongated buttonhole.

Step 3.—*Search for and isolation of the sympathetic nerve:* Retract the muscle and with it the packet of cervical vessels and nerves (carotid artery, internal jugular veins, vagus nerve) inwards and upwards. Two blunt hooks or one wide blunt retractor are useful for this purpose. Look for the nerve in the middle of the wound, either on the posterior surface of the sheath of the vascular packet with which the nerve may have been retracted inwards or on the vertebral column, where it lies in a special aponeurotic sheath. The nerve is easily found. It is impossible to confound it with the vagus, the descending branch of the hypoglossal (descendens noni), or the phrenic. To dispel all doubt as to identity follow the nerve upwards and see the superior ganglion (Fig. 185).

Step 4.—*Isolation and resection of the superior ganglion:* Follow the nerve-trunk upwards to the ganglion and isolate the *latter from below upwards* by blunt dissection with a director.

Divide its afferent and efferent fibres with blunt-pointed curved scissors. When the upper end of the ganglion is isolated, divide or tear the trunk which leads from it towards the skull (Fig. 186).

Step 5.—Liberation of the inferior thyroid artery: This artery is surrounded by a dense and often adherent nervous plexus consisting of the sympathetic trunk and its branches. The nerve often is swollen at this point, forming the middle cervical ganglion.

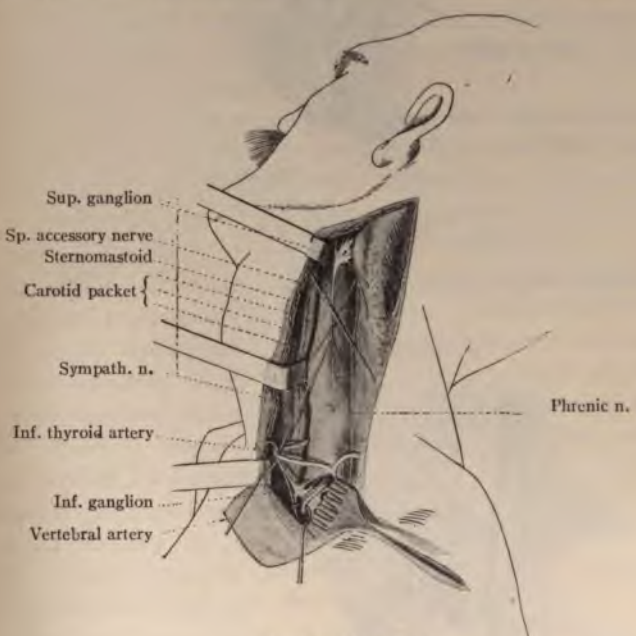


FIG. 185.—(*Jonnesco.*)

Put tension on the nerve-trunk already isolated and follow it downwards. Elevate the nerve and the inferior thyroid artery together and separate them by careful blunt dissection (Fig. 187).

Step 6.—Isolation and resection of the inferior ganglion: This is the most difficult step in the operation, as the ganglion lies deeply imbedded in a special lodge at the base of the neck or

even in the thorax, behind the clavicle, against the neck and head

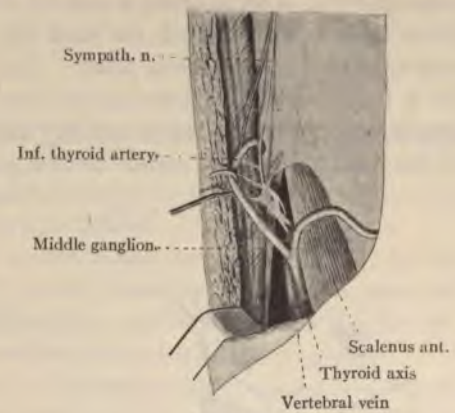


FIG. 186.—(*Jonnesco.*)

of the first rib, between the scalenus anticus and longus colli muscles, and just above the pleura. Using the trunk of the nerve as a guide, penetrate to the ganglion, which lies sometimes internal to, and sometimes (though rarely) external to, the vertebral artery. The ganglion is adherent to the artery and enlaces it in a meshwork of its efferent and afferent fibres (Fig. 187). With apprproiate retractors retract the scalenus anticus, thyroid axis, and the vertebral artery and vein, downwards and outwards; retract inwards and forwards the

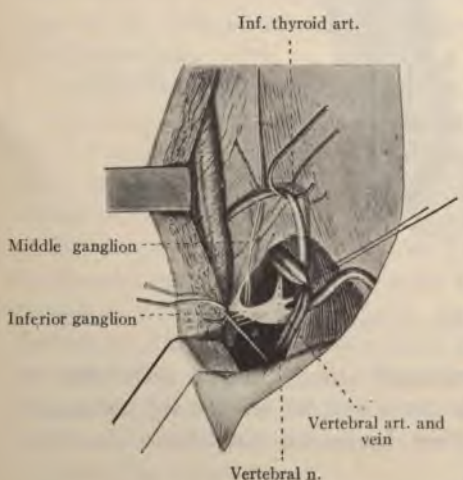


FIG. 187.—(*Jonnesco.*)

sternomastoid muscle and the carotid sheath with its contents. Divide, with a grooved director, the cellular and aponeurotic tissues covering the vessels and the ganglion. Seize the ganglion with forceps and isolate it successively from the vertebral artery externally and from the rib and spine internally. Isolate and divide the afferent and efferent fibres, and remove the ganglion.

The dangers which may be encountered are:

1. Injury to the vertebral artery and vein.
2. Injury to the first intercostal artery or its cervical branch.
3. Injury to the subclavian artery, especially on the left side.
4. Injury to the pleura.
5. Friability of the ganglion, rendering *morcellement* necessary.
6. Intimate union of the inferior cervical and first thoracic ganglia into one mass, from which a portion must be removed.
7. Injury to the retroclavicular venous plexus. This accident will be rare if the trunk of the nerve is followed closely.

Step 7.—Suture of the wound: Close the wound completely with buried and superficial catgut sutures. The superficial stitches ought to be introduced in the intradermic fashion so as to leave little scar. There should be no drainage. Apply dressings.

Immediately after operation on one side the corresponding pupil dilates, the face flushes, eye waters, and nose secretes abundantly. These phenomena, except the pupillary dilatation, are very transitory. The pulse falls below normal for a few days; after partial resection of the sympathetic it is accelerated. The operation seems to have no ill effects.

After the patient has recovered from the operation on one side the other side should be attacked in the same manner.

Jonnesco considers the above operation of total bilateral excision of the cervical sympathetic indicated:

1. In exophthalmic goitre or Basedow's disease.
2. In epilepsy.

Usually the lowest ganglion is not removed. Excision of the two upper ganglia has been useful in cases of glaucoma. The operation of sympathectomy may prove to be one of value; it is still, however, *sub judice.*

CHAPTER XVI.

RETROPHARYNGEAL ABSCESS AND TUMORS.

There are two methods of opening retropharyngeal abscess, viz., through the mouth and through the neck.

1. **Opening the Abscess through the Mouth.**—No anæsthetic, not even cocaine, is permissible. If the pharynx and larynx were anæsthetized, there would be increased danger from inspiration of discharges. A knife, the edge of which is protected with cotton or adhesive plaster to within one inch of the point, is guided on the finger of the left hand through the mouth to the posterior wall of the pharynx. An incision is made into the abscess at its most prominent point. The knife is at once withdrawn. If the patient is a child, the operation should be performed in Rose's position—*i. e.*, with hanging head, and in any case as soon as pus begins to flow the head should be lowered and the body elevated. The after-treatment consists in the use of antiseptic gargles and sprays and in keeping the wound open by daily probing, if this is necessary.

2. **Drainage through the Neck.**—*Chiene's Operation.*—Make an incision two inches in length along the posterior margin of the sternomastoid, beginning at the apex of the mastoid process and running downwards. After division of the deep fascia one can by blunt dissection reach the anterior surface of the bodies of the cervical vertebræ where the abscess is situated. The skin and fascia having been incised as above, the pus may be reached and evacuated by Hilton's method. This is a very safe and easy procedure.

Remarks.—Retropharyngeal abscess may be acute or chronic. It is only for the former that operation through the mouth is suitable. On purely theoretical grounds the operation through the

mouth must be condemned for the following reasons: (*a*) When the pus begins to flow there is danger of asphyxiation. (*b*) No dressings can be applied to soak up discharges and keep out dirt. (*c*) There is grave danger of septic pneumonia and of infection to the gastro-intestinal canal. (*d*) If the case is one of tuberculous abscess, secondary infection is certain. *Practically* it has been found that by using Rose's position or by inverting the patient during the first flow of pus the danger of asphyxiation is averted, and that in acute cases rapid recovery does ensue. An advantage is claimed for this operation, viz., that an anæsthetic is not necessary, but certainly in case of need the external operation can be done under a local anæsthetic.

The advantages of the external route are: (*a*) The possibility of careful removal of diseased foci, *e. g.*, diseased bone, etc.; (*b*) the possibility of treating the abscess antiseptically and providing for permanent drainage; (*c*) the possibility of avoiding secondary infection; (*d*) the avoidance of the danger of drowning the patient in his own pus.

The principal disadvantage is the scar which must be left, but as a rule it is not very noticeable.

Retropharyngeal Tumors.—I. The tumor is not adherent to the spinal column, but is movable. Perform tracheotomy. Tampon the larynx or trachea. Place the patient in Rose's position. Introduce a mouth-gag and open the mouth. Pierce the tongue with a needle and pull through a stout thread which serves as a handle to manipulate the tongue. Make an incision through the mucous membrane of the posterior pharyngeal wall and expose the tumor freely. Busch has shown that the tumor lies loosely imbedded in the retropharyngeal tissues and can be shelled out. Generally blunt dissection with closed curved scissors will result in easy removal of the growth. Clean the pharyngeal cavity and the wound with a non-poisonous antiseptic.

If necessary to obtain more room, the soft palate may be divided longitudinally. This wound must be closed by suture as soon as the tumor is removed.

II. The tumor is so extensive that removal through the

mouth is impossible. The pharynx must be opened from the neck.

Step 1.—Make a U-shaped incision beginning in front of the masseter and ending at the tip of the mastoid process. The lowest part of the U reaches below the level of the hyoid bone. Doubly ligate and divide the external jugular vein. Reflect upwards the skin-flap outlined by the incision (Fig. 188).

Step 2.—Divide the cervical fascia along the anterior margin of the sternomastoid. Expose the external carotid artery. This artery, partly covered by the internal jugular vein, should be sought on the line of the anterior margin of the sternomastoid between a point on a level with the hyoid and one on a level with the upper edge of the thyroid cartilage. Before tying the vessel expose at least one of its branches. This precaution is recom-

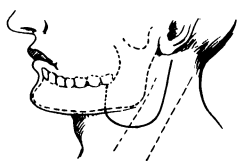


FIG. 188.

mended because the internal has occasionally been mistaken for the external carotid.

Step 3.—Doubly ligate the artery and divide it between the ligatures. Expose as thoroughly as possible such part of the tumor as may present between the inferior maxilla and the mastoid. If it is feasible to remove the tumor through this space, do so; otherwise proceed to the next step.

Step 4.—Cut through the soft structures covering the inferior edge of the horizontal ramus of the lower jaw at a point just in front of the masseter muscle. Through this incision with an elevator separate the periosteum from the bone sufficiently to allow of subperiosteal section of the bone. With finger saw, forceps, Gigli's wire or the chain saw divide the bone. Dislocate the temporo-maxillary joint and turn the ascending ramus of

the jaw upwards together with the soft parts covering it. This gives very free access to the pharyngeal wall.

Step 5.—Isolate the tumor by blunt dissection if possible. *Do not open* the pharyngeal cavity before it is absolutely necessary to do so. Remove the growth.

Step 6.—Pack the cavity with iodoform gauze. Replace the dislocated portion of the lower jaw and wire it in position. Close most of the wound in the soft parts by interrupted silkworm-gut sutures, leaving an opening through which the gauze pack protrudes. Dress.

In one case the writer was surprised to find that he was able to shell out in the above manner a large tumor affecting the right side and roof of the pharynx, without tearing or dividing the pharyngeal mucous membrane.

As a preliminary to the operation tracheotomy may or may not be performed. If the growth, either from size or location, does *not* interfere with respiration; if the surgeon ligates the external carotid artery near its origin and does not open the pharynx until the tumor is almost entirely separated and hemostasis has been secured, then a preliminary tracheotomy appears superfluous.

CHAPTER XVII.

ŒSOPHAGUS.

Œsophagotomy.—The œsophagus may be opened either in the neck or in the posterior mediastinum. The latter operation is discussed elsewhere.

Cervical œsophagotomy is performed for the removal of foreign bodies, the treatment of stricture, the excision of small, sharply defined tumors, or as a step in the operation of œsophagostomy. Place the patient on the table with shoulders slightly elevated and the face turned towards the right. Beginning at the level of the thyroid cartilage, make an incision downwards for about three inches along the anterior margin of the left sternomastoid muscle. Divide the platysma, superficial and deep fasciæ. The omohyoid may be divided or retracted according to convenience. Retract the thyroid gland and trachea towards the right. Notice, in the wound, the common sheath containing the carotid, internal jugular, and vagus. Retract these structures to the left. The œsophagus will now be exposed. If a foreign body is present, fix the œsophagus with small volsellum forceps and make a longitudinal cut into it over the foreign body. If necessary, enlarge the wound with a probe-pointed bistoury or with scissors. Gently extract the foreign body. This frequently requires much patience. The incision through the œsophagus should be made on the side, as the recurrent laryngeal lies in the groove between it and the trachea.

When no foreign body is present distending the œsophagus, pass an œsophageal bougie through the mouth and cut down upon it when incising the gullet wall.

Through the œsophageal wound one may divide or forcibly dilate a stricture or even remove a small tumor. For such pur-

poses, however, the operation will be but little used, as strictures are generally more suitably treated by other means, and tumors eradicable by the above operation must be of great rarity.

Closure of the Wound.—Close the œsophageal wound by a row of sutures of fine catgut not involving the mucosa. Lessen the size of the external wound by a few stitches at its upper and lower extremities. Loosely pack the remainder of the wound with iodoform gauze. Apply plentiful dressings. Treves advises the use of some orthopædic apparatus to secure rest for the parts.

For the first day or two after the operation the patient should be nourished by means of enemata; subsequently food should be administered through a small soft-rubber stomach-tube passed through the mouth. This method of feeding must be kept up until it is evident that the œsophageal wound has healed. The cervical wound requires frequent dressing and the mouth must be washed at short intervals with some antiseptic lotion. The great danger to be apprehended is sepis, especially septic mediastinitis.

Œsophageal Diverticula.—Diverticula occasionally are present in the neck and communicate with the œsophagus or pharynx. When these are large, food passes into them and serious symptoms, even death, may result. The condition is often unrecognized by the physician. In serious cases operation is demanded.

The Operation.—Proceed as in œsophagotomy. Retract the trachea towards the right, the sternomastoid and the sheath containing the carotid, internal jugular, and vagus to the left. Pass an œsophageal bougie through the mouth into the diverticulum, if this is possible. Recognize the diverticulum and its relations to surrounding structures. Remove the bougie. Separate the diverticulum from its surroundings. This can generally be accomplished by blunt dissection. Where the diverticulum joins the œsophagus its neck may be as thick as a man's thumb. Divide the neck layer by layer close to the œsophagus. With catgut, suture the wound of the mucous membrane. The wound of the outer tunics of the neck of the diverticulum is closed by an

invaginating suture like Lembert's intestinal stitch. Partially close the external wound. Provide very free drainage by means of iodoform gauze. The after-treatment is the same as that for œsophagotomy. When the diverticulum is comparatively small, the skin-incision need not be longer than that for œsophagotomy; but when it is large, then the incision must be longer. It is better to make an incision longer than is absolutely necessary than to be cramped, while operating, through lack of room.

CHAPTER XVIII.

PHARYNGOTOMY, LARYNGOTOMY, PARTIAL LARYNGECTOMY, AND LARYNGECTOMY.

SUBHYOID PHARYNGOTOMY.

Place the patient on his back, the shoulders supported on a cushion and the head extended. Palpate the hyoid bone and thyroid cartilage.

Step 1.—Make a transverse cutaneous incision immediately below and parallel to the hyoid bone. If the operation is for the purpose of exposing the entrance to the larynx, an incision two inches in length is sufficient; if for the removal of a tumor of the pharynx or upper larynx, the incision must be much longer.

Step 2.—Divide the platysma myoides, the omohyoid, sternohyoid, and thyrohyoid muscles close to the hyoid bone, but leaving sufficient of their substance attached to the bone to permit of their union by suture.

Step 3.—Divide the thyrohyoid membrane along the posterior surface of the hyoid, the knife being directed backwards and upwards. Leave enough membrane attached to the bone to permit the use of sutures when closing the wound. Attend to hemostasis.

Step 4.—The mucosa now pouts into the wound during expiration; seize it with forceps and divide it. Be careful not to injure the epiglottis. Insert two catgut sutures into the upper edge of the wound in the mucosa to act as guides or tractors when closure is begun. Pull the epiglottis out of the wound and insert into it a suture to be used as a tractor. The upper part of the larynx and the lower pharynx now lie exposed, and one may proceed to remove any foreign body or accessible tumor. If the operation is done for malignant disease of the upper zone of

the larynx (extrinsic disease—Semon), or if any hemorrhage is anticipated, it is well to perform a preliminary tracheotomy.

Step 5.—Close the wound in the mucosa with fine catgut sutures. Unite the thyrohyoid membrane, the divided muscles, and the skin each by a separate layer of sutures. Insert a small drain of gauze or oiled silk down to the line of suture, closing the wound in the mucosa. If a large part of the pharynx has been excised, it is wise to pack the cavity with gauze and only partially close the wound with sutures; under these circumstances a tracheotomy will have been performed.

TRANSHYOID PHARYNGOTOMY.

Vallas obtains access to the pharynx by a median incision.

Step 1.—Make a median cutaneous incision from a point one fingerbreadth above the hyoid to the thyroid notch. Divide the skin, subcutaneous tissue, etc., and separate the mylohyoid muscles.

Step 2.—Denude a small portion of the hyoid bone in the middle line and divide the bone with scissors or forceps. Retract the two halves of the hyoid and the attached soft structures. This gives a space about 1½ inches in width, and exposes the mucous membrane of the pharynx above and the thyrohyoid membrane below the bone.

Step 3.—Guided by a finger passed into the pharynx through the mouth open the pharynx, cutting from above downwards.

Step 4.—Having attended to the disease which necessitated operation, close the wound with several layers of suture, after providing for drainage. It is unnecessary to suture the hyoid bone.

LARYNGOTOMY AND PARTIAL LARYNGECTOMY.

Laryngotomy is an operation in which the larynx is split open, its interior exposed, and any foreign body or disease removed. The operation is frequently accompanied by partial laryngectomy.

The Operation.—*Step* 1.—Perform a low tracheotomy. Insert a Trendelenburg or a Hahn cannula.

Step 2.—Make a median incision from a point immediately below the hyoid bone to one just below the cricoid cartilage. Divide the cervical fascia to the full extent of the wound. Separate the sternohyoid muscles by blunt dissection.

Step 3.—Incise the cricothyroid membrane after fixing the cricoid cartilage with a sharp hook or small volsellum forceps. With a probe-pointed strong knife, with strong scissors, or with thin-bladed bone forceps divide the thyroid cartilage accurately in the middle line. When the cartilage is very hard, Treves advises the use of a fine saw instead of the bone forceps. In such cases probably it might be easier and less damaging to pass a Gigli wire saw through the wound in the cricothyroid membrane, behind the thyroid cartilage and out through a cut in the thyrohyoid membrane, and saw through the cartilage in the middle line from within outwards.

Step 4.—Retract the lateral halves of the thyroid cartilage with sharp hooks.

Step 5.—Remove the foreign body or tumor or excise the laryngeal contents completely.

Step 6.—Either completely or partially close the larynx with sutures. Partial closure, a gauze wick being left for twenty-four hours to drain the lower angle of the wound in the larynx, is preferable to complete closure.

Step 7.—Replace the Trendelenburg by an ordinary tracheotomy cannula. In Step 5 various degrees of interference may be requisite. Even in cases of rather extensive malignant disease below the vocal cords (intrinsic disease) thorough removal of the growth and surrounding soft parts *plus* energetic scraping of the cartilage often gives good results. If the growth invades the cartilage, then portions of that structure must be removed. Sir F. Semon ("Brit. Med. Jour.," Oct. 31, 1903) limits the term partial laryngectomy to cases where *not less* than one wing of the thyroid cartilage, with, possibly, a part of the cricoid and one arytenoid, is removed. Removal of small fragments of these

cartilages he includes under the name "thyrotomy." The lymphatics of the larynx may be considered as being in two groups, one above the other, below the true vocal cords. The cords have very scanty and thin lymphatics which drain into the supraglottic zone for the most part. The network of lymphatics above the vocal cords (supraglottic zone) is very dense, easily injected, covers the epiglottis, the aryteno-epiglottic folds, the superior or false vocal cords, and the ventricles of the larynx. The subglottic zone of lymphatics is not so dense as that above. "Though the two lymphatic territories of the larynx largely communicate with each other in the posterior walls of the larynx, it is rare to obtain a complete injection of the endolaryngeal network by puncturing only one of these territories. It may be added that injections easily cross the middle line; but though the mass injected into one-half of the larynx easily passes into the mucous membrane of the other side, it is, on the other hand, exceptional for it to pass as far as the corresponding glands of that side." ("The Lymphatics," Poirier, Cuneo, Delamere. Leaf's translation.)

The great importance of the above anatomical facts is very evident and they show very clearly the reasonableness of Semon's dicta regarding the conditions required for successful thyrotomy for malignant disease. Semon gives the name "extrinsic malignant disease" to that situated in the supraglottic lymphatic zone, and "intrinsic" to that in the subglottic zone.

Conditions Essential to the Success of Thyrotomy for Malignant Disease.—1. Operation must be restricted to *early* stages of intrinsic malignant disease.

2. Early diagnosis is indispensable.

3. Operation must be thorough. No sentimental considerations as to the amount of vocal power to be retained must interfere with the removal of sufficient healthy tissue from around the neoplasm in all directions.

4. Laryngoscopic examination rarely gives correct information as to the extent of the disease. If, on opening the larynx, the disease is found to invade the cartilages, partial laryngectomy

must be performed, "or indeed any other operation, the necessity of which may become apparent when the extent and depth of infiltration of the new growth have been definitely ascertained."

Intra-laryngeal operations are useless in the face of malignancy: they merely take away portions of the growth and may stimulate it to more rapid development. Even in cases where there is doubt, but malignancy is strongly suspected, thyrotomy is the proper operation. When the disease is situated on the posterior laryngeal wall or when it is too advanced for thyrotomy or partial laryngectomy to be successful, then total laryngectomy becomes a necessity. In cases of extrinsic malignant disease of the larynx subhyoid pharyngotomy gives the best access for its removal.

LARYNGECTOMY.

Complete Laryngectomy.—The operation of laryngectomy is called for in cases of malignant disease of the larynx. Usually cases in which the disease has broken through the bounds of the larynx and invaded neighboring tissues are considered inoperable, but, as will be seen in succeeding pages, such cases have been successfully attacked. The greatest danger of laryngectomy is, not the immediate risk of the operation, but the subsequent aspiration of wound secretions into the lungs, causing pneumonia. This danger is combatted by careful asepsis, or, better, antisepsis, and by using the resources of plastic surgery. After operation it is wise to encourage the patient to leave his bed as early as possible.

The Operation.—Step 1.—Perform a low tracheotomy and insert a Trendelenburg cannula to prevent the entrance of blood into the lungs.

Step 2.—Make an incision in the middle line from the hyoid bone to below the cricoid cartilage. This divides all the soft parts down to, but not through, the cartilages and their connecting membranes. If necessary, convert the vertical into a T-shaped incision by means of a transverse cut near the hyoid bone.

Step 3.—(A) Separate the soft parts which are connected with

the laryngeal cartilages, on each side, from the larynx. Do this as much as possible by blunt dissection; an occasional cut with knife or scissors will be necessary. In making this separation keep close to the cartilaginous walls of the larynx. The larynx is now exposed anteriorly and laterally; it is still united to the hyoid bone above, to the trachea below, and to the œsophagus behind.

(B) If the disease has infiltrated surrounding structures, then of course this step of the operation must be carried out by means of dissection beyond the disease. The operation becomes, in fact, one for the excision of a tumor in which the larynx happens to be located.

Step 4.—Stop all bleeding. Divide the thyrohyoid membrane transversely close to the upper edge of the thyroid cartilage. Injure the œsophagus as little as possible. Examine the epiglottis carefully. If it is diseased or if its appearance is doubtful, remove it. Carefully separate the posterior wall of the larynx from the œsophagus, but always bear in mind the necessity of getting beyond the disease. The larynx is now attached to the body by the trachea alone. If possible, cut through the cricoid cartilage transversely and remove the larynx. If the cricoid is diseased or in a suspicious condition, make the section through the trachea at as low a point as may be necessary.

Step 5.—Suture the divided trachea to the skin. The trachea is liable to be retracted downwards. Stop all bleeding. Introduce an œsophageal tube into the gullet to permit of feeding. Pack the wound with iodoform gauze. Apply dressings. Replace the Trendelenburg cannula by an ordinary tracheotomy tube.

After-treatment.—Give the patient fluid food through the œsophageal tube, which is left *in situ*. It is probably better to omit the introduction of the œsophageal tube at the time of operation, but to pass the tube each time the patient requires nourishment. The wound should be frequently dressed and the mouth should be kept clean.

In order to avoid confusion the author has described the operation of laryngectomy as if the removal of the diseased larynx constituted the whole of the procedure. It would be almost as logical to amputate the cancerous breast without removing the fatty and lymphatic contents of the axilla as to remove the larynx without attacking the cervical lymphatics at the same time. When the larynx has been removed and provision has been made to retain control of the divided trachea (Step 5), it is easy to gain access to the cervical lymphatics and to remove them in the manner described in another chapter (page 145) or by some slight modification of that method.

Fig. 189.

Fig. 190.

FIGS. 189 AND 190.—(*Monod and Vanverts.*)

Perier's Operation.—In extirpating the larynx Perier discards the aid of a preliminary tracheotomy.

Step 1.—Make a vertical median incision from the hyoid bone down to a point well below the cricoid cartilage. Make two horizontal incisions, one at each end of the vertical cut. The wound is now I-shaped.

Step 2.—Separate the soft parts from the larynx and upper part of the trachea, as has been already described. With a curved blunt instrument introduced laterally separate the larynx and upper portion of the trachea from the œsophagus (Fig. 189).

Step 3.—Stop all bleeding. Introduce a stout thread on each side of the trachea below the line where it is to be divided. These threads are for purposes of traction. Rapidly divide the trachea immediately below the cricoid cartilage and pull the stump upwards and forwards by means of the traction threads (Fig. 190). Introduce into the trachea a large curved cannula provided with lugs through which the traction threads may be passed and fastened. The ends of the threads are left long. The threads prevent the cannula changing its position and can still be used for traction purposes. The anæsthesia is continued through the cannula.

Step 4.—Complete the extirpation of the larynx. Close the wound with sutures after providing for drainage.

Fig. 191.—(*Monod and Vanverts.*)

Step 5.—Suture the tracheal opening to the lowest angle of the wound (Fig. 191).

Th. Gluck brings the tracheal stump out through a special buttonhole in the skin near the sternal notch, thus isolating it from the laryngectomy wound.

Keen's Method.—In 1898 Keen described a method of operating the details of which lead towards safety. For several days prior to operation brush the teeth thoroughly and spray the nose and fauces with a mild antiseptic every two hours, when the patient is awake.

Step 1.—Give chloroform. Median incision from above the hyoid bone nearly to the sternum. Expose the thyrohyroid membrane, larynx, and two or more tracheal rings. Divide the isthmus of the thyroid.

Step 2.—Separate the structures to be removed from their lateral connections. Attend to hemostasis.

Step 3.—Put patient in Trendelenburg's position. Divide

the trachea transversely well below the disease and below the area of the beard in men (lest hair grow into the trachea). With three sutures fix the upper end of the trachea to the skin. Introduce an ordinary tracheotomy tube ½ inch in diameter. Secure the tube with sterile tapes passed round the neck. Continue the anæsthetic through a sterile rubber tube passed into the cannula and provided with a funnel.

Step 4.—Pull the upper end of the trachea forwards, and by blunt or sharp dissection separate it from the œsophagus. Close any accidental wounds of the œsophagus at once with Lembert sutures. Remove the disease and the larynx.

Step 5.—Pull the epiglottis into the wound and remove it.

Step 6.—Suture the anterior wall of the œsophagus to the tissues just below the hyoid bone. This must be done thoroughly to prevent leakage from the mouth into the wound.

Step 7.—Remove the tracheotomy cannula and close the external wound. Provide drainage for twenty-four hours. Apply dressings above and below the tracheal opening, which is protected by any framework—*e. g.*, a pill-box without top or bottom—covered with gauze to filter the air.

After-treatment.—Put to bed without bolster or pillow. Raise the foot of the bed on a chair. Get the patient up as soon as possible (about the third day). For one or two days feed by enemata. By the third day the patient can swallow.

Föderl has paid great attention to means of avoiding post-operative pneumonia due to the aspiration into the lungs of secretions from the open wound generally left after laryngectomy. The method of operating adopted by him is based on experience gained in a case of tracheal stenosis. In this case he resected the affected portion of the trachea and restored continuity by means of a circular suture of the windpipe. The result was perfect. After the trachea has been divided, and provided it is not abnormally adherent to its surroundings, it is very easily pulled up. On the cadaver it has been shown that the larynx may be completely excised, the hyoid bone united by sutures to the first ring of the trachea, the head thrown into a position of over-extension, and that the sutures will still hold.

the laryngeal cartilages, on each side, from the larynx. Do this as much as possible by blunt dissection; an occasional cut with knife or scissors will be necessary. In making this separation keep close to the cartilaginous walls of the larynx. The larynx is now exposed anteriorly and laterally; it is still united to the hyoid bone above, to the trachea below, and to the œsophagus behind.

(B) If the disease has infiltrated surrounding structures, then of course this step of the operation must be carried out by means of dissection beyond the disease. The operation becomes, in fact, one for the excision of a tumor in which the larynx happens to be located.

Step 4.—Stop all bleeding. Divide the thyrohyoid membrane transversely close to the upper edge of the thyroid cartilage. Injure the œsophagus as little as possible. Examine the epiglottis carefully. If it is diseased or if its appearance is doubtful, remove it. Carefully separate the posterior wall of the larynx from the œsophagus, but always bear in mind the necessity of getting beyond the disease. The larynx is now attached to the body by the trachea alone. If possible, cut through the cricoid cartilage transversely and remove the larynx. If the cricoid is diseased or in a suspicious condition, make the section through the trachea at as low a point as may be necessary.

Step 5.—Suture the divided trachea to the skin. The trachea is liable to be retracted downwards. Stop all bleeding. Introduce an œsophageal tube into the gullet to permit of feeding. Pack the wound with iodoform gauze. Apply dressings. Replace the Trendelenburg cannula by an ordinary tracheotomy tube.

After-treatment.—Give the patient fluid food through the œsophageal tube, which is left *in situ*. It is probably better to omit the introduction of the œsophageal tube at the time of operation, but to pass the tube each time the patient requires nourishment. The wound should be frequently dressed and the mouth should be kept clean.

In order to avoid confusion the author has described the operation of laryngectomy as if the removal of the diseased larynx constituted the whole of the procedure. It would be almost as logical to amputate the cancerous breast without removing the fatty and lymphatic contents of the axilla as to remove the larynx without attacking the cervical lymphatics at the same time. When the larynx has been removed and provision has been made to retain control of the divided trachea (Step 5), it is easy to gain access to the cervical lymphatics and to remove them in the manner described in another chapter (page 145) or by some slight modification of that method.

Fig. 189.

Fig. 190.

FIGS. 189 AND 190.—(*Monod and Vanverts.*)

Perier's Operation.—In extirpating the larynx Perier discards the aid of a preliminary tracheotomy.

Step 1.—Make a vertical median incision from the hyoid bone down to a point well below the cricoid cartilage. Make two horizontal incisions, one at each end of the vertical cut. The wound is now I-shaped.

Step 2.—Separate the soft parts from the larynx and upper part of the trachea, as has been already described. With a curved blunt instrument introduced laterally separate the larynx and upper portion of the trachea from the œsophagus (Fig. 189).

paid no attention to preserving the thyroid isthmus, but has divided it whenever it seemed convenient to do so.

Step 2.—The trachea is now bare to the extent of three or four rings. Fasten the trachea with a sharp hook a little to one side of the middle line. Let an assistant hold the hook. Guided by the finger, introduce a knife slowly but steadily into the trachea at the lower end of the exposed area. Be careful not to push the knife in so far as to injure the posterior wall of the trachea. Cut upwards in the middle line until three tracheal rings are divided. Hold the knife in position in the trachea until, guided by the knife, one can insert into the trachea a closed hemostat or blunt-pointed narrow-bladed scissors. Withdraw the knife. Open the blades of the hemostat or scissors so as to distend the tracheal wound, and slip a tracheotomy tube into position. There are many manœuvres or dodges to facilitate the introduction of the cannula; the one described has suited the author. A few surgeons discard the cannula but suture the edges of the tracheal wound to the corresponding edges of the skin. One suture on each side suffices to keep the tracheal opening patent. The writer has had no experience of this method, but in emergency would not hesitate to try it.

The Low Operation.—The steps in the operation are very similar to those of the high operation. The incision begins near the cricoid cartilage and runs downwards for two inches. After the cervical fascia is divided blunt dissection will serve to expose the trachea. All veins which appear during the dissection must be drawn aside or divided between ligatures or forceps. The index finger of the left hand should be frequently put into the wound to feel the position of the trachea and to discover if any abnormal artery is in the way. The author well remembers the glee with which the late Sir John Struthers used to exhibit a specimen showing an enormous abnormal artery crossing the territory involved in a low tracheotomy. If the isthmus of the thyroid appears, it should be pulled upwards. The trachea is opened in exactly the same manner as is done in the high operation.

The low operation is not suitable in children, as in them the trachea is very deeply situated, their necks are short, and the thymus gland gets in the way. For adults and adolescents the low operation is suitable.

When the operation is performed in cases of obstruction from external pressure, *e. g.*, in cases of goitre, and some obstruction exists below the tracheotomy opening, a tube should be passed down the trachea beyond the obstruction. In emergency one may use a gum-elastic catheter for this purpose, passing it through the tracheotomy cannula. König has devised a special

Fig. 194.—König's Cannula.

Fig. 195.—Trendelenburg's Cannula.

FIGS. 194 AND 195.—(*Esmarch and Kowalzig.*)

metal cannula with a long pliable tube which is occasionally of service (Fig. 194). When a tracheotomy tube has to be worn for a long time, those made of hard rubber are less irritating and more durable than the usual metal ones. Fenestrated tubes permit the patient to breathe through the natural passages, and are useful to test whether it is safe to discard the cannula or not.

Trendelenburg's cannula (Figs. 195 and 196) has rubber so arranged around the intra-tracheal part of the tube that it can be inflated and fill up the space between the trachea and the tube, thus preventing the entrance of blood, etc., into the lungs. This can-

nula is of great service during certain operations on the upper air-passages, as through it anæsthetics may be administered.

Instead of surrounding the tube with an inflatable rubber bag, some surgeons prefer to cover the tube with compressed sponge, which when moistened swells *in situ* and serves the same purpose. (Hahn's cannula, Fig. 197.) When a tracheotomy cannula is in position, it must be retained by means of a tape passed round the neck and secured to the eye-holes provided in the instrument. The inner tube should be frequently removed and cleaned. During the first few days after operation the outer tube should never be removed except by the surgeon.

Fig. 196.—Trendelenburg's Cannula *in situ*.

Fig. 197.—Hahn's Cannula.

FIGS. 196 AND 197.—(*Esmarch and Kowalzig.*)

Patient or nurse should never be permitted to remove the outer tube until the surgeon has satisfied himself by observation that they are capable of replacing it.

Tracheotomy is occasionally performed as a preliminary to such operations as excision of the larynx, Kocher's excision of the tongue, etc. Preliminary tracheotomy is either mediate or immediate. When the "mediate" operation is chosen, it should be performed two or three weeks before the major operation to which it is preliminary.

The advantages claimed for mediate tracheotomy are: (1) The patient has free respiration for a period of weeks and so

may gain strength. (2) The patient becomes accustomed to respiring air which has not passed through the nose and mouth. (3) The tracheal wound becomes fixed to the soft parts, thus anchoring the windpipe and preventing retraction after the larynx, for example, has been excised. (4) The tracheotomy having been done beforehand, the duration of the major operation is shortened thereby.

Advocates of the immediate operation claim: (1) That the time consumed in performing tracheotomy is not sufficient seriously to influence the success of the major operation; (2) that it is unnecessary to accustom the patient beforehand to breathing through a cannula; (3) that while the patient is breathing through the cannula discharges from the cancerous tongue or larynx are liable to gravitate down the trachea, past the cannula into the lungs, and cause pneumonia, while the resisting power of the lungs is lowered from receiving air directly through the tracheotomy tube; (4) that if any attempt is to be made to restore the continuity of the windpipe after laryngectomy, the adhesions formed around the tracheotomy wound will prevent the necessary elevation or pulling up of the lower trachea.

In the opinion of the author the disadvantages of mediate tracheotomy are greater than the advantages, and the immediate operation is preferable, except when it is preliminary to excision of the tongue.

CHAPTER XX.

GOITRE; BRONCHOCELE; STRUMA.

It may not be out of place to remind the reader that there are several varieties of goitre: viz., Parenchymatous, where there is uniform enlargement of the thyroid tissues; Adenomatous, where the glandular tissue is in excess and forms single or multiple tumors; Cystic, where from degeneration a cavity is formed filled with colloid or other fluid and often containing adenomatous masses. There is also that form known as "exophthalmic goitre," where the tumor is associated with notable general symptoms. In any of the above varieties operation may be required.

FIG. 198.—POSTERIOR VIEW OF TRACHEA, ETC., SHOWING COURSE OF RECURRENT LARYNGEAL NERVE.—(*Esmarch and Kowalzig.*)

Indications for Strumectomy.—The position, size, and character of the goitre may each constitute a positive indication for operation. Position and size may give rise to respiratory and circulatory troubles, as well as to interference with nerves. The character of the disease indicates whether or not internal treatment may be of value. Soft colloid nodules usually decrease and occasionally disappear during internal treatment. Diffuse strumata are those most suitable to medication with iodine administered externally and internally. Medical treatment must be stopped as soon as it is shown to be ineffective, or the slightest

evidence of iodism or of Basedow's disease appears (de Quervain).

The local use of iodine is liable to cause adhesions around the goitre and thus render operation more difficult. Injections of iodine or such like drugs are always improper.

Almost all forms of goitre are suitable for operation if causing symptoms or deformity or increasing in size rapidly. Tetany is liable to follow operations on diffuse follicular goitres where the

FIG. 199.—SUPERFICIAL VEINS OVER A GOITRE.—(*Esmarch and Kowalzig.*)

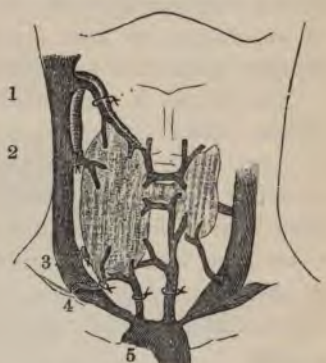


FIG. 200.—(*Esmarch and Kowalzig.*) 1. Superior thyroid artery and vein. 2. Superior thyroid vein. 3. Accessory inferior thyroid vein. 4. Inferior thyroid vein. 5. Thyroidea ima veins (chief and accessory).

whole gland is uniformly involved. In exophthalmic goitre (Basedow's, Graves' disease) the use of iodine is more dangerous than in other forms. Remember that Graves' disease often remains stationary or improves under any or no treatment, hence operation is by no means always called for, but remember also that, as the disease progresses, the powers of resistance decrease, hence operation must not be too long delayed.

The chief local characteristic of exophthalmic goitre is the great vascularity of the gland. The principle of treatment is to

remove degenerated segments and decrease the blood-supply. Kocher, since 1890, has done this by multiple ligation of the thyroid arteries and partial excision. This work he accomplishes in several sittings. Most surgeons operate in these cases exactly as in ordinary goitre.

Besides the two lateral lobes and isthmus which compose the thyroid gland, the remnant of the thyroglossal duct running up from the isthmus often forms an extra lobe, the pyramidal lobe, and along its course there may be developed irregular masses of glandular tissue—accessory thyroids. The frequent presence of these extra masses of thyroid is not surprising, as the thyroid itself is developed from the thyroglossal duct; surgically they are of importance, as their presence is calculated to confuse the operator ignorant of their existence.

The thyroid is surrounded by a strong covering of fascia—fibrous capsule. When a goitre is present in the gland (adenoma or cyst), it is, of course, surrounded by more or less altered glandular tissue—glandular capsule. The word capsule, being applied both to the outer fibrous covering and to the glandular tissue inside which the tumor lies, leads to confusion when methods of operating are described. In the succeeding pages the outer or true capsule will be called the fibrous, the inner, the glandular, capsule.

The arteries of the thyroid are—(*a*) The superior thyroid, entering the upper pole of the lateral lobe; (*b*) the inferior thyroid, entering the posterior surface of the lower pole and in close and, surgically, dangerous relation to the recurrent laryngeal nerve (Fig. 198); (*c*) the thyroidea ima, entering the isthmus from below.

The veins of the thyroid are of very great importance; a study of Kocher's schemata (Figs. 199 and 200) will give a fair idea of their location and importance.

Operations for the cure of goitre may be divided into three groups: I. Excision; II. Intraglandular enucleation; III. Incision and evacuation.

I. EXCISION.

Complete excision of the thyroid gland is an unjustifiable operation, as it is followed by fatal consequences. As in the case of other organs, nature has been lavish in her provision of functional material in the thyroid, and it is safe to say that one-fourth of the gland is sufficient for the maintenance of health.

Partial Excision—Excision of One Lobe.

Method A.—Kocher's Transverse Incision.—Step 1.—Over the most prominent part of the tumor make a slightly curved transverse incision (concavity upwards) from the outer surface of one

FIG. 201.—(*Kocher.*)

sternomastoid muscle to a corresponding point on the other. Make the incision too long rather than too short, as thorough exposure is the key to safety. Divide the skin and platysma. Reflect the divided tissues upwards and downwards; the sternohyoid, sternothyroid, omohyoid, and inner margin of the sternomastoid muscles lie more or less exposed. Find the anatomic middle line of the neck. Remember that a unilateral goitre pushes this line towards the opposite side (Fig. 201). In the median line divide the fascia uniting the right and left muscle groups. Do this extensively both upwards and downwards

under guidance of the finger passed under the fascia. Pass the finger under the muscles of the diseased side immediately below the larynx and divide them transversely to the extent necessary for *thorough* exposure of the tumor. Demonstrate the fibrous capsule of the thyroid and split it without injuring the gland beneath. Division of the fibrous capsule is absolutely essential.

Step 2.—With the finger separate the fibrous capsule from the anterior surface of the gland, at the same time pulling the muscles and fibrous capsule outwards with blunt retractors. Any veins (accessory veins) passing from the fibrous capsule to the gland must be doubly ligated and divided. Do the same for the outer and posterior surfaces (Figs. 202, 203, and 204). Now dislocate the goitre and pull it out of the wound. This removes pressure from the trachea. If a general anæsthetic is being used, warn the anæsthetist before dislocating the gland.

Fig. 202.

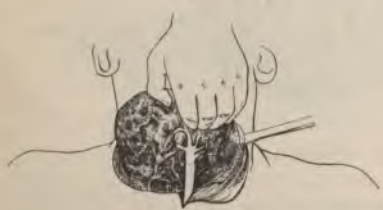


Fig. 203.

FIGS. 202 AND 203.—(*Kocher.*)

Step 3.—Systematic ligation of vessels.

(*a*) With Kocher's director push the fibrous capsule inwards and outwards from the upper pole of the thyroid until the superior thyroid artery and vein are isolated like a pedicle. Divide these between ligatures applied tightly (Fig. 205).

(*b*) Vigorously retract the muscles (sternomastoid, etc.) of the affected side. Firmly pull the goitre over towards the sound side (Fig. 206). The inferior thyroid artery lies on the deep muscles of the neck and may be felt as a transverse or oblique

pulsating cord running from the outer side, under the carotid to the thyroid gland, where that structure is attached to the trachea. Isolate the artery with great care and precision, because close to it is the recurrent laryngeal nerve. Only apply one ligature to the vessel. Many surgeons ligate each branch of the inferior thyroid close to the gland and so avoid the nerve.

Fig. 204.

Fig. 205.

FIGS. 204 AND 205.—(*Kocher.*)

(*c*) At the lower pole of the tumor on its median side look for, doubly ligate, and divide the thyroidea ima artery and the accompanying veins (Fig. 207).

Step 4.—Isolate the thyroid isthmus. Doubly ligate and divide all vessels visible on it. Catch the isthmus in strong forceps (Fig. 208) and crush it forcibly. Remove the crushing forceps. Doubly ligate the gutter crushed in the isthmus with single or chain ligatures and divide it.

FIG. 206.—(*Kocher.*)

Step 5.—The gland now remains attached to the trachea and cricoid by its inner margin. If this portion of the gland is healthy, cut away the gland in such a manner as to leave a thin layer *in situ*, protecting the recurrent laryngeal nerve. Ligate any bleeding vessels.

Step 6.—Wash the wound with hot salt solution. Examine

for any bleeding points. Return any divided muscles to their normal place and unite them by sutures. Provide for drainage. Close the wound. Apply dressings. The drainage must be removed in twenty-four hours if no fluid blood is escaping.

FIG. 207.—(*Kocher.*)

Method B.—Angular Incision (*Kocher*).—Beginning on the sternomastoid muscle at the level of the thyroid cartilage, make an incision through the skin and platysma, reaching to the median line and following the direction of the natural folds or creases of the skin. Continue the incision downwards in the middle line to the notch of the sternum. Reflect the angular skin-flap and expose the sternomastoid, which must be retracted outwards. The rest of the operation is the same as in Method A. This method of exposure is of much value in cases where the goitre extends far upwards or downwards.

FIG. 208.—(*Kocher.*)

Method C.—v. Mikulicz's Method of Resection.—The following description is from v. Mikulicz's article, quoted by Berry ("Diseases of the Thyroid Gland"): "I began the operation, intending to perform the ordinary one of removal of the left lobe, and hoping to be able to leave the right intact. In the course of the operation, however, it became evident that the right *lobe lay partly* behind the sternum, and would, if left, prove a

source of danger to the patient. So instead of doing the usual extirpation, I resected this lobe in the following manner: First of all it was isolated as far as possible in the usual way with blunt instruments. The smaller blood-vessels were tied with double catgut sutures. I then tied the superior thyroid artery and vein in the ordinary manner at the summit of the lobe; also the superficial vessels passing to the lower part of the gland. I now, by means of short snips of the scissors, freed that portion of the tumor which was adherent to the front and side of the trachea, but took care not to go too far back, so as not to come into collision with the recurrent laryngeal nerve. Eventually the whole tumor was attached only to the angle between the trachea and œsophagus, where it covered the recurrent nerve and inferior thyroid artery. This attached portion, the hilus of the gland, I treated like the short, thick pedicle of an ovarian tumor. . . . While my assistant with his fingers compressed the vessels entering the hilus, I split the pedicle lengthwise with blunt scissors into several portions, seized each of these in a strong pair of pressure forceps, and placed catgut ligatures in each of the clefts so formed. Then the goitrous mass was cut off with scissors, leaving a pedicle of 5–10 mm. ($\frac{1}{5}$–$\frac{2}{5}$ inch) in length. The forceps squeezed out nearly all the glandular tissue, leaving in their grasp little but connective tissue. The result was that the catgut ligatures could easily and safely be placed around the separated portions of the pedicle. Not a drop of blood came away from the cut surfaces; only here and there in the intervals was a little oozing; this slight hemorrhage was easily stopped by the application of a few ligatures. The remainder of the gland had now shrunk to a lump about as large as a chestnut, which lay in the angle between the trachea and œsophagus. Neither recurrent nerve nor inferior thyroid artery came into view on this side."

The above operation has been frequently repeated and has proved very successful. The advantages of the procedure are: (*a*) avoidance of the recurrent nerve; (*b*) retention of portions of the lobes attacked, and hence the possibility of removing parts of both lobes.

Method D.—Resection-enucleation (Kocher).—This method is very like that of v. Mikulicz, but avoids leaving large ligated masses near the location of the recurrent nerve. Kocher has noticed that when many large pedicles are ligated near the nerve the necessary contraction of the tissues by the ligature often causes injury to it.

The Operation.—Step 1.—Expose the anterior surface of the diseased half of the thyroid as in Method A. Crush (with forceps), ligate, and divide the isthmus close to the disease.

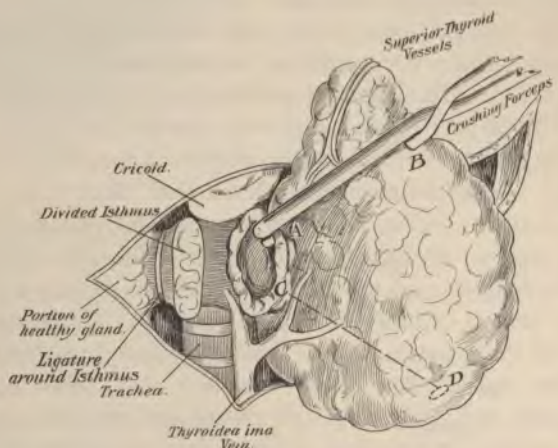


FIG. 209.

Step 2.—Through the cut surface of the isthmus the goitrous nodule will present (Fig. 209). Beginning at the isthmus wound, with the finger or Kocher's director penetrate the glandular capsule down to the disease and separate the former from the nodule along the lines A B and C D. Note that the separation of glandular capsule from goitrous nodule is only along these two lines. With strong forceps crush the glandular capsule along the lines of separation, remove the forceps, apply ligatures to the crushed tissue, and divide the glandular capsule.

Step 3.—Grasp the goitrous nodule and overlying glandular capsule and separate this mass from the posterior portion of the glandular capsule until all that connects the goitrous mass to the body is the outer portion of the glandular capsule (B D, Fig. 209) well external to the line of the recurrent nerve. Crush this portion of the capsule; ligate and divide it.

By the above procedure the diseased tissues are removed, and with them the anterior portion of the gland. All the posterior surface of the gland is left, which is advantageous because danger to the recurrent nerve is avoided and much useful glandular tissue is retained. Hemorrhage is less than in enucleation. Kocher says that this operation, while very valuable, is of more limited application than excision. It is inapplicable in cases of diffuse follicular colloid degeneration.

II. INTRAGLANDULAR ENUCLEATION.

Step 1.—Expose the anterior surface of the diseased lobe by Method A or B. (See "Excision.")

Step 2.—Note the most prominent part of the tumor, and at this point freely incise the glandular capsule. Before incising, clamp or doubly ligate any prominent vessels. Be sure to penetrate to, but not into, the tumor.

Step 3.—With blunt dissection, using the finger, Kocher's director, or closed blunt scissors, shell the tumor out of its glandular capsule. Sometimes this is more easily accomplished if the fluid contents are drawn off, as in the case of a large ovarian cyst. The shelling-out must be done rapidly, as bleeding is often abundant. The surgeon must always keep his instrument close against the tumor-wall, otherwise the vascular glandular capsule will be injured and more bleeding provoked.

Step 4.—Immediately on the removal of the tumor temporarily pack the cavity with gauze and pull the whole cavity forwards. Gradually remove the gauze, and with forceps, ligatures, and catgut stitches stop hemorrhage. The hand placed behind the thyroid can press the floor of the wound cavity forwards within

reach and control. Hemostasis must be absolute, as primary union is of great importance.

Step 5.—Provide for drainage for twenty-four hours. A tubular drain is best. Close the wound with sutures. For this purpose Berry uses three layers of fine sutures. One layer obliterates the cavity in the gland, another unites the muscles, and a third, the skin-wound.

III. INCISION AND EVACUATION; MARSUPIALIZATION.

In certain cases of cystic goitre where repeated attacks of inflammation have caused the formation of many adhesions none of the preceding methods are applicable, and a simpler operation must be done.

Step 1.—Make an incision over the most prominent portion of the tumor and expose a few inches of its surface.

Step 2.—Doubly ligate the vessels of the tumor capsule (both fibrous and glandular capsules) and incise the tumor. Stitch the edges of the wound in the cyst-wall to the skin.

Step 3.—Explore the cyst with the finger and shell out all degenerated colloid masses. Stop bleeding by means of forceps, ligatures, hemostatic sutures, hot water, and packing. Drain the cavity.

The great objection to this procedure is the open wound which is left, the dangers of subsequent infection, and the possible persistence of a fistula; its advantages are ease of accomplishment and immediate safety. The operation has a distinct though limited field of usefulness.

PART II.—THE THORAX.

CHAPTER I.

OPERATIONS ON THE BREAST.

Evacuation of Abscess by Incision.—The classical method of incising the breast to empty an abscess is exceedingly simple. Make an incision through the skin, beginning peripheral to the *areola*, and along a line radiating from the nipple and situated over the inflammatory swelling. By combined sharp and blunt dissection penetrate the abscess, clean the cavity, and provide drainage. The object of radial incision is to avoid transverse and unnecessary division of glandular structures.

To avoid deformity from scars it has been suggested to use the principle of Thomas' operation for adenomata of the breast. Make a curved incision along the line of junction of the lower edge of the breast and the chest-wall. Penetrate to, but not through, the pectoral fascia. Separate the breast from the chest-wall until it is possible to gain access to the abscess from the deep surface of the gland. Evacuate the pus. Introduce one or two drainage-tubes into the cavity and bring their ends out through the wound. Replace the mamma on the thoracic wall. Partially close the skin-wound by sutures.

In this operation the incision is larger and the dissection is much greater than is required in simple incision, but the drainage is excellent and the resulting scar is below the breast and hidden by the natural fold existing there.

Excision of Non-malignant Neoplasms of the Breast.—I. When the breast is the seat of very large or multiple non-malignant neoplasms, the whole organ must be excised, but it is not

necessary to remove the pectoral fascia or axillary contents. Make an oblique elliptical incision over the breast and including the nipple. This incision runs from above and outwards, downwards, and inwards; it begins and ends just beyond the confines of the gland. Through the incision dissect the skin free from the breast, and by blunt and sharp dissection separate the breast from the pectoral fascia and remove it. Attend to hemostasis. Close the wound.

The operation is perhaps the easiest in surgery. When there is doubt as to the malignancy or non-malignancy of the disease present, and histological examination is, for any proper reason, not convenient, then the above operation should *not* be performed; the patient ought to be given the benefit of the doubt and radical measures adopted.

II. When the breast is the seat of one or perhaps of two or three small non-malignant neoplasms, such may be excised, leaving the gland practically intact.

Method A.—Fix the neoplasm by grasping it between the finger and thumb. Make an incision over the tumor, peripheral to the nipple areola, along a line radiating from the nipple. Expose the tumor by this incision and either shell or dissect it out of its bed. Attend to hemostasis. Close the wound, with or without drainage.

Method B.—Thomas' operation has the great advantage of avoiding visible scars. It has been sufficiently described on page 195.

Excision of the Breast for Cancer.—A few years ago typical excision of the breast could be completed in a few minutes. The operation consisted in making an elliptical incision over the breast and including the nipple, in rapidly reflecting the skin from the gland, and in tearing and cutting the gland from the pectoral fascia. Through the wound the finger was pushed up into the corresponding axilla, and if any lymphatic glands were found enlarged, such were removed. The operation was primarily safe. The ultimate results were such that many experienced surgeons claimed recurrence always took place. Disgusted with

the want of success attained, thoughtful operators became more radical and more successful. The typical operation no longer consisted in removal of the mamma and the axillary glands if they were palpably diseased, but the mamma, the pectoral fascia, the axillary glands, and fat were removed in one piece. The primary mortality of the operation did not increase perceptibly; the ultimate results were infinitely bettered.

The Operation.—The incision A, B, C (Fig. 210) is made through the skin. The ellipse between B and C includes the nipple and any portions of skin which may be adherent to the tumor. The skin-flap A B C E is reflected downwards well below the limits of the breast and to the posterior border of the axilla (*i. e.*, to the edge of the latissimus dorsi). The skin-flap A B C D is reflected upwards well above the limits of the breast and so as to expose the anterior boundary of the axilla. Beginning below the breast, one dissects from the pectoralis major the fat of the chest-wall, the pectoral fascia, and with them the diseased mamma. This is continued to a point well above the breast, to the base of the skin-flap A B C D. There is now a mass of fat, gland, and pectoral fascia *unconnected* with the chest-wall, but *continuous* with the fatty and lymphatic axillary contents. The chest wound is to be protected by an aseptic pad or towel and the surgeon attacks the axilla. Beginning on the *outer* or arm side of the axilla, its fatty contents are dissected from the vessels and nerve-trunks there situated. The first effort should be to dissect the axillary vein free from its fatty surroundings. Any axillary branches of the vein should be divided between two fine ligatures whenever found. When this dissection is being made, the arm should be kept as close to the body as is consistent with free access to the axilla; the object attained by doing so is that otherwise branches of the axillary vein would be put on the stretch and

FIG. 210.

rendered unrecognizable, and further that in this position it is possible to retract the pectoralis major upwards, thus giving access to the apex of the axilla.

The contents of the axilla are easily separated from the posterior and internal walls of the space. If it is convenient to save the small nerves crossing the axilla, they may be preserved; but if, as is usually the case, time would be lost in so doing, they should be sacrificed. The only connection left between the mass to be removed and the body is at the apex of the axilla. If the lymphatics higher up are believed to be healthy, this connection is divided and the excision is complete. If, on the other hand, it is suspected that the disease extends further, then the pectoralis major is divided and access is gained to the chain of lymphatics running up under the clavicle. These are removed in one piece with the tumor mass. The wound in the muscle is sutured. The whole wound is closed, axillary drainage being provided.

When the pectoral fascia is being removed from the pectoralis major, should any disease be found or suspected to exist in that muscle the whole muscle must be excised in one piece with the mamma.

The operation, as described, is not one for a novice, but in the hands of an experienced surgeon it is safe and has given results which, when compared to those previously obtained, might almost be described as brilliant. Halsted has still further elaborated the operation, making it *tremendously* extensive and most remarkably successful. His success is so great that the author considers the Halsted operation or some modification thereof to be the preferable treatment for operable mammary cancer.

Halsted Operation.—(The following description is compiled from Halsted's articles in the "Annals of Surgery," vol. xx, No. 5, and xxviii, No. 5.)

Principle of Operation.—The pectoralis major muscle, entire or all except its clavicular portion, should be excised in every case of cancer of the breast, because the operator is enabled

thereby to remove in one piece all the suspected tissues. The suspected tissues should be removed in one piece.

Step 1.—The skin-incision is carried at once and everywhere through the fat (Fig. 211).

Step 2.—The triangular flap of skin A B C is reflected back to its base line, C A. There is nothing but skin in this flap. The fat which lined it is dissected back to the lower edge of the pectoralis major muscle, where it is continuous with the fat of the axilla.

Step 3.—The costal insertions of the pectoralis major are severed and the splitting of the muscle, usually between its clavicular and costal portions, is begun, and continued to a point about opposite the scalenus tubercle on the first rib.

FIG. 211.

Step 4.—At this point the clavicular portion of the pectoralis major and the skin overlying it are cut through hard up to the clavicle. This cut exposes the apex of the axilla.

Step 5.—The loose tissue under the clavicular portion of the pectoralis major is carefully dissected from this muscle as the latter is drawn upwards by a broad sharp retractor. This tissue is rich in lymphatics *and is sometimes infected with cancer.*

Step 6.—The splitting of the muscle is continued out to the humerus, and the part of the muscle to be removed is now cut through close to its humeral attachment.

Step 7.—The whole mass, skin, breast, areolar tissue, and fat, circumscribed by the original skin-incision, is raised up with some force, to put the submuscular fascia on the stretch as it is stripped from the thorax close to the ribs and pectoralis minor muscle. It is well to include the delicate sheath of the minor muscle when this is practicable. This step has been modified by Halsted in

that he now ("Annals of Surgery," Nov., 1898) removes the pectoralis minor and exposes the subclavian vein at its inner part.

Step 8.—The axilla is now stripped of its contents and its anterior wall at one time, from within outwards and from above downwards. The axillary contents are dissected away with scrupulous care and with the sharpest possible knife. The axillary vein should be stripped absolutely clean. Not a particle of extraneous tissue should be included in the ligatures which are applied to the branches, sometimes very minute, of the axillary vessels. In liberating the vein from the tissues to be removed it is better to push the vein away from the tissues rather than, holding the vein, to push the tissues away from it. It may not be necessary, but it is well to expose the artery and remove the possibly infected tissue above it. It is best to err on the safe side and remove in all cases the loose tissue above the vessels and about the axillary plexus of nerves.

Step 9.—Having cleaned the vessels, we may proceed more rapidly to strip the axillary contents from the inner wall of the axilla—the lateral wall of the thorax.

Step 10.—When we have reached the junction of the posterior and lateral walls of the axilla, or a little sooner, an assistant takes hold of the triangular flap of skin and draws it outwards, to assist in spreading out the tissues which lie on the subscapularis, teres major, and latissimus dorsi muscles. The operator cleans the posterior wall of the axilla from within outwards. The subscapular vessels are exposed and caught before being divided. The subscapular nerves may or may not be removed.

Step 11.—Having passed these nerves, the operator has only to turn the mass back into its normal position and to sever its connection with the body of the patient by a stroke of the knife from B to C, repeating the first cut through the skin.

Step 12.—This step did not belong to Halsted's original operation, but has been added by him subsequently. Make a vertical incision parallel to and near the posterior margin of the sterno-mastoid muscle, dividing a few of the posterior fibres of the muscle. Expose the junction of the internal jugular and sub-

clavian veins. Divide the omohyoid muscle at its tendinous part and draw its two bellies out of the way. Remove the supraclavicular fat by dissecting downwards and outwards from the venous junction, and the infraclavicular fat by dissecting from below. By elevating the shoulder the clavicle can be raised an inch or more away from the first rib when the operation is so far completed as to make this desirable. The web of fibrous tissue which binds the subclavian vein loosely to the clavicle is thus spread out and can be easily removed. The fingers can be passed from the supraclavicular to the infraclavicular and to the subscapular regions under the clavicle, and any fat in the latter region, near the internal or the posterior border of the scapula between the serratus magnus and subscapular muscles, which could not be well reached from the axilla, can be drawn out through the neck.

FIG. 212.—(*Kocher.*)

Step 13.—Review the whole wound. Unite the divided omohyoid by a catgut suture. Close the wound in the neck. The edges of the chest wound are approximated by a buried purse-string suture of strong silk. Of the triangular flap of skin (A B C, Fig. 211) only the base is included in this suture. The rest of the flap is used as a lining for the fornix of the axilla. The axilla is never drained. The open wound remaining on the chest is immediately covered with Thiersch's skin-grafts.

Many surgeons, the author included, have devised modifications of the Halsted procedure and have found such satisfactory. Only Kocher's operation will be here described:

Step 1.—With the knife make a few superficial scratches on the skin to mark out the line of incision which is shown in Fig. 212. From the clavicle to the edge of the anterior axillary fold,

near the insertion of the pectoralis major, complete the incision through the skin, subcutaneous tissue, and fascia. Expose the cephalic vein in the groove between the pectoralis major and deltoid, thus recognizing the upper edge of the pectoralis. Pass the finger around the pectoralis major one to two fingerbreadths from the humerus. Guided by the finger, divide the pectoralis major.

FIG. 213.—(*Kocher.*)

Step 2.—The pectoralis minor now lies exposed to view. Divide this muscle near the coracoid process, and expose the great vessels and nerves of the axilla.

Step 3.—Beginning above, near the clavicle and coracoid process, dissect the fat from the axillary vessels and nerves, and then dissect it free towards the thoracic wall. By this means the most difficult step of the operation is completed while the surgeon is fresh, without the annoyance of the loose mass of mamma, etc., getting in the way, as in the Halsted operation, and while the chest is still protected against chill by its fatty coverings, which will be removed later.

Step 4.—Complete the incision around the breast (Fig. 212). Excise the mamma, surrounding fat, and both pectoral muscles. The wound left is large (Fig. 213).

Step 5.—After attending to hemostasis, close the wound, as much as possible, by sliding the flaps together. Where the wound cannot be closed, cover it with Thiersch's skin-grafts. Provide for axillary drainage by a tube introduced posteriorly.

After such extensive removal of important muscles one would

naturally expect very serious loss of function, but such is not the case; the author has been assured by various patients that they are able to attend to their own housework and to dress their own hair satisfactorily.

CHAPTER II.

OPERATIONS ON THE CHEST.

OPERATIONS ON THE PLEURAL CAVITY.

Exploratory Puncture.—The existence of fluid in the pleural cavity is diagnosed or suspected; by exploratory puncture its presence and character are determined. Choose a point on the chest-wall corresponding to the location of the suspected fluid. Clean the skin thoroughly. Choose a hypodermic syringe with a long and not too fine needle and sterilize them. Insert the needle into the pleural cavity at a point just *above* a rib. This avoids danger of injuring the intercostal vessels. Slowly withdraw the piston of the syringe. If fluid is found, preserve it for examination; if it is not found, the operation should be repeated at several points and the needle examined after each withdrawal lest it should have become plugged. No dressings are required.

Thoracentesis.—The object of the operation is the removal of fluid from the pleural cavity. The operation may be: (*a*) *Exploratory.* The fluid withdrawn is examined microscopically. If tuberculosis is suspected, the examination should include the inoculation of guinea-pigs. (*b*) *Therapeutic.* In adults when the fluid is not infected, the operation is curative. In children even when the fluid is infected a cure often results.

Strict asepsis must be maintained; otherwise a simple effusion into the pleura may be converted into an empyema, or to the bacteria which have already produced an empyema there may be added others which may markedly increase the intensity and gravity of the disease. Dennis advocates surrounding with rubber sheets the area to be washed, so as to avoid chilling the patient unnecessarily with the antiseptic washes. The patient

should be placed in a semi-erect posture, if necessary being propped up with pillows. If he is weak, give him a stimulant of strychnine or alcohol.

The favorite points for operation are the eighth intercostal space near the angle of the scapula and the sixth near the mid-axillary line. Clean the patient's skin. If desired, inject a few drops of a 2 per cent. solution of cocaine into the skin at a point over the rib near its upper edge. With a fine knife make a puncture through the skin at this point. Pull the skin-wound upwards so that the needle of a Potain aspirator (thoroughly disinfected) can now be introduced and made to pass into the chest in contact or nearly so with the upper edge of the rib. The object of puncturing the skin with the knife is that, the skin being tough, so much force is required to push the aspirating needle through it that, the skin once passed, the needle is liable to be jerked into the tissues. Another reason is that disinfection of the deep layers of the skin being practically impossible, the needle cutting its way through may conceivably become infected and do harm.

In whatever way the skin is penetrated, the puncture through it should not be opposite that through the deep structures; a valvular wound is desired. The needle is made to hug the upper edge of a rib so as to avoid injuring intercostal vessels. Having introduced the needle, aspiration is begun. If fluid does not come, this may be due to the needle having become clogged with tissue or a clot of fibrinous material. A stiletto passed through the needle will free its lumen. If obstruction to the lumen is not the cause of failure to obtain fluid, the needle should be *partially* withdrawn and reintroduced in another direction. Working, as one does, in the dark, several punctures may be necessary before the fluid is found or one is satisfied that it is absent.

When the fluid flows, let it flow slowly. If the patient coughs or has a feeling of oppression, stop the flow until he recovers. The same must be done if the pulse alters markedly or the patient becomes faint. As the fluid escapes the patient may be

lowered in his bed. If the effusion is great, it is wise to stop the operation before the fluid is nearly all removed. The remainder may be absorbed. The sudden, complete emptying of the sac is likely to do harm.

Thoracotomy.—The object of thoracotomy is to drain the pleural cavity. Local or general anæsthesia may be employed. preferably local. Make an incision two inches in length parallel to the ribs at a point just anterior to the edge of the latissimus dorsi muscle and corresponding to the sixth, seventh, or eighth intercostal space. Along the lower border of the space cut through the intercostal muscles. Attend to hemostasis. Make a *small* opening through the parietal pleura. Too rapid evacuation of the pus is dangerous, as it too suddenly alters conditions of intrathoracic pressure. As the pus flows, enlarge the opening with forceps or the finger. Explore the empyema cavity with the finger and remove all shreds of tissue or clots of fibrin floating in the cavity. If such are left behind, they are liable to interfere with drainage and delay recovery. Do not irrigate the cavity. This has proved dangerous. Above all, do not use antiseptic irrigation. Drain by means of tubes passed into the pleural cavity. Not much of the tube should project into the pleura. The tubes may be rigid or soft. The writer generally uses a portion of a large soft-rubber catheter. To prevent the tube slipping into the pleura either stitch it to the skin or transfix it with a large safety-pin. If necessary (it rarely is necessary), partially close the skin-wound with sutures. Surround the outer end of the drain with sterile gauze in bird-nest fashion. This prevents direct pressure on the tube. Apply abundant dressings. Some surgeons place oiled silk over the mouth of the drainage-tube to act as a valve, allowing the escape but not the entrance of air into the pleura. This is unnecessary. After the pleura has been penetrated, a counteropening may seem desirable. To make this, pass a forceps through the wound, through the cavity, and with its point elevate the tissues at the position selected. Cut down on the forceps and push them through the new wound. Grasp a perforated rubber tube in

the jaws of the forceps and pull the tube through the cavity. We thus have efficient through-and-through drainage. Ochsner is a great advocate of this through-and-through drainage. If at any time it is desired to withdraw this tube and introduce another, fasten a stout thread to the end of it and in withdrawing the tube pull the thread through the cavity; with this thread *in situ* it is easy to introduce another tube. Later the tube may be replaced by a few strands of silkworm-gut. Tubular drainage must be kept up until all discharge has ceased. In cases of pneumococcic infection recovery is usually rapid, the lung expanding and obliterating the empyema cavity. When the infection is streptococcic, many weeks may elapse before the infected cavity becomes obliterated. Some surgeons, to make drainage more perfect and continuous, connect the drainage-tube to a pipe passing through the dressings and attached to a Bunsen's air-pump (Fig. 214). This ingenious measure is not often required. During the after-treatment of cases of thoracotomy the patient should be placed in the position found at the operation to be most favorable for drainage. This position, especially if disagreeable, need not be kept up continuously, but adopted at intervals for a short time. It is wise to encourage the patient to sit up and move about at as early a date as possible. Fresh air is of great value in treatment.

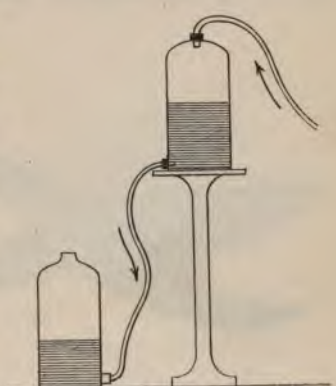


FIG. 214.

Thoracotomy with resection of a segment of rib is usually much preferable to simple intercostal incision. In the latter the space is limited, finger exploration is difficult or impossible, and when the tube is introduced, it is very liable to be pinched between the ribs and rendered useless. Removal of a segment

of one or more ribs does no permanent harm and the operation is exceedingly easy. In operating on non-localized empyema the incision may be made over the sixth or seventh rib in the mid-axillary line, or over the ninth rib just external to the angle of the scapula, which is the best position. In cases of localized empyema the opening must of course be made over the encapsulated pus. When incision is made in the mid-axillary line, the patient must be brought to the edge of the table, over which the affected side may protrude a little. When the posterior site of operation is chosen, place the patient, with the sound side uppermost, in a position midway between the lateral and ventral—*i. e.*, lying half over on his belly. *The sound side must never be*

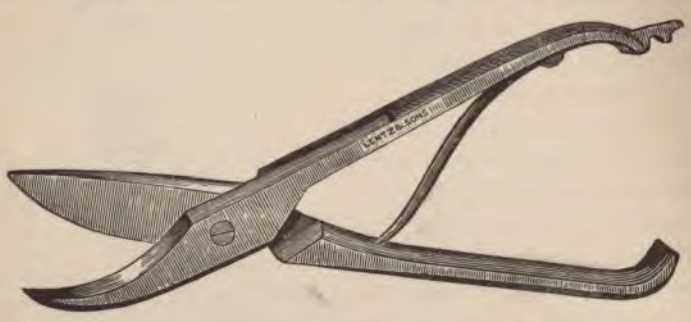


FIG. 215.

undermost, otherwise respiration will be impeded. The surgeon under these circumstances stands in front of the patient and reaches the site of the operation by leaning over him.

The Operation.—1. Make an incision two to three inches in length along the long axis of the chosen rib and divide the periosteum along a line midway between the upper and lower borders of the rib.

2. With a curved periosteal elevator separate the periosteum from the bone both externally and internally. The intercostal vessels are separated from the bone with the periosteum. In recent cases much care must be exercised when detaching the periosteum from the deep surface of the bone lest the pleura be

prematurely opened; in cases of long duration there is so much pleural thickening that no accident is likely to happen.

3. Divide the exposed rib at the posterior end of the wound with bone forceps or rongeurs. For this purpose a costotome (Fig. 215) is convenient but not necessary. Grasp the portion of bone to be removed in the jaws of a sequestrum forceps, steady and bring it forwards, and divide it anteriorly with bone forceps. Two inches of bone should be removed.

4. Make a small incision through the deep layer of periosteum and the pleura. Let the pus flow out slowly. Proceed as in thoracotomy. If the cavity is large, it is easy to resect portions of two ribs subperiosteally through the same external incision. If this is done, the intercostal muscles and vessels should be ligated behind and in front of the pleural incisions and the two horizontal openings into the pleura united by a vertical cut to form an I-shaped wound (Fig. 216).

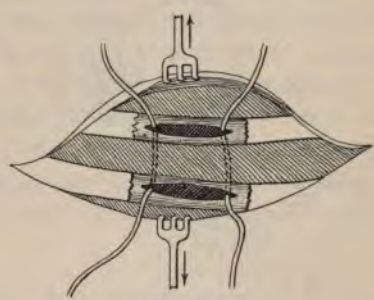


FIG. 216.

The cure of an empyema by drainage depends, first, on the free escape of the pus; and, secondly, on expansion of the lung obliterating the pleural cavity and permitting the more or less complete adhesion of the parietal and visceral layers of the pleura. When the lung is unable to expand and approach the chest-wall, obliteration of the cavity may be obtained by bringing the chest-wall to the lung. To accomplish this is the object of thoracoplasty. Before deciding for or against thoracoplasty it is of prime importance to know whether or not the lung is capable of expanding sufficiently to fill the thoracic cavity. For this purpose Perles' method of examination is good. (F. Karewski, "Die deutsche Klinik," viii, 313.) It is as follows:

I. Measure the capacity of the cavity by pouring into it an

indifferent liquid from a vessel holding a known quantity. When the cavity is full, it is easy to calculate its capacity by noting the amount of liquid left in the vessel and subtracting it from the amount originally in it.

II. Measurement of the expansile power of the lung: The drainage-tube or cannula emerging from the empyema is connected by a tube to the graduated cylinder X (Fig. 217), at the top of which is a stopcock (S) and at the bottom a tube leading to a jar of water (D). The stopcock is closed and the cylinder and lower tube are full of water. Atmospheric pressure prevents the water leaving X as long as the stopcock S remains closed. Open S, and at once the water in the cylinder X falls, aspirating air from the empyema cavity as long as the lung continues to expand. Whenever the water in the cylinder rises and falls with the patient's inspiration and expiration, it shows that the lung has approached the chest-wall as closely as it can. The amount of air now in the cylinder (X) can be read on the graduated scale, and represents how much the empyema cavity has been diminished by long expansion.

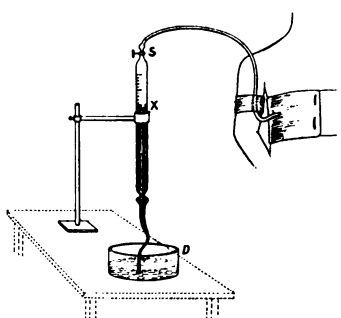


FIG. 217.

Compare the results obtained by these two methods of examination. If the capacity of the cavity (known by Method I) is not very different from the expansile power of the lung (Method II), then it is wise not to proceed to thoracoplasty before trying some method of suction drainage. If there is a marked difference between the capacity of the cavity and the expansile power of the lung, thoracoplasty is proper.

Estlander's Operation.—Make a subperiosteal resection of three or four ribs (about 4 inches of each) through separate incisions, exactly as in thoracotomy with resection of rib. Instead

of using separate skin-incisions the ribs may be exposed by a **U**-, **T**-, **H**-, or **I**-shaped incision, the soft parts being reflected as a flap or flaps, and then the ribs resected superiosteally. This operation permits a falling-in of the chest-wall, but in many cases the parietal pleura is so thick and hard that it is inelastic, and the desired retraction of the chest cannot take place. To obtain proper retraction the following procedure has been adopted:

Schede's Operation (*Thoracoplasty*).—Beginning at the origin of the pectoralis major at the level of the axilla make an incision which goes downwards in a curve to the bottom of the pleural sac,—*i. e.*, the tenth rib in the posterior axillary line,—crosses the chest-wall from the front to the back, and ascends to the level of the second rib at a point between the spine and the scapula. Reflect upwards the huge flap thus outlined, and include in it *all* the tissues superficial to the ribs and intercostal muscles. Resect subperiosteally all the ribs over the cavity, from their tubercles to their insertion into the costal cartilages. To do this it is best to divide the rib at its middle with bone forceps, and, grasping the divided end of one of the fragments with sequestrum forceps, dissect it out of its periosteal bed. The other fragment is removed in the same fashion.

Bardenheuer has been compelled to excise even the first rib, the clavicle, and the scapula before he could obtain a satisfactory result.

Make a large incision through the thickened pleura to permit of thorough exploration. This exploration tells how many ribs must be excised and to what extent. Excise *all* the periosteum, intercostal muscles, and thickened pleura over the empyema cavity. There is not liable to be much hemorrhage from the intercostal vessels, owing to their being more or less obliterated by the disease, but the patients are usually debilitated, the operation is very severe, and hence it is necessary to clamp and ligate all the intercostal vessels. Hemostasis must be very carefully attended to. Some surgeons carefully scrape away all diseased granulation tissue, but all that is necessary is gentle wiping with gauze pads. Replace the flap of soft parts. This flap, at least

if the disease has been extensive, will not by any means cover the defect, as its under or raw surface must be in contact with the outer surface of the retracted lung. Fasten the flap in position with sutures and properly applied gauze pads, so as to insure good contact between flap and lung. The remainder of the cavity must be filled with sterile (not iodoform) gauze and may subsequently be covered by Thiersch's skin-grafts or by flaps of skin. No poisonous antiseptics should be used during the operation, and the use of iodoform gauze is forbidden, owing to the great absorbing power of the tissues in question. Karewski finds vioform gauze as efficacious as iodoform, and perfectly safe as regards poisoning. Instead of replacing the reflected flap, Cheyne and Burchard recommend packing the whole cavity with gauze for a time, to permit of free drainage and of the formation of a layer of granulations on the deep surface of the flap.

As has been said, the operation is very severe, and the patients are always debilitated; hence it is often wise to refrain from completing the operation at one sitting, but to proceed step by step, *e. g.*, excising the ribs and indurated pleura from over the lower part of the empyema, and after this procedure has been recovered from to advance higher.

The incision described is that of Schede, but an infinite variety of cuts have been advocated; as Kümmel (quoted by Karewski) says, almost one-third the letters of the alphabet have been imitated in forming incisions.

Delorme, Fowler, Beck, and others believe that the obstruction to obliteration of the empyema cavity is not so much the rigid chest-wall as the stiff, indurated, shrunken visceral pleura which imprisons and compresses the lung. These surgeons temporarily resect the thoracic wall, free the lung from its prison by "decortication," and close the chest. Jordan and Krause combine the method of decortication with Schede's operation. Most surgeons use decortication as an aid to excision of the thoracic wall, but discard the temporary resection.

Pulmonary Decortication.—George R. Fowler ("Med. News," June 15, 1901; "Am. Year-Book of Med. and Surg.,"

1902) performed this operation in 1893 with very gratifying results. He writes: "An elliptical-shaped incision was made to include the orifice of the sinus, the soft parts cleared, and about 3½ inches each of the fifth and sixth ribs removed. . . . . Commencing at the site of the opening in the chest-wall, the pleura was isolated by blunt dissection in the direction of the diaphragm until the latter was reached. It was then peeled off the latter until its limit towards the median line was reached, where it was found to rest against the displaced pericardium, from which, after much difficulty, it was finally detached. This dissection was greatly impeded by the movements of the diaphragm as well as those of the heart. The dissection was completed by lifting the mass and finally detaching it from the lung above. Considerable expansion of the lung followed at once, and in the course of twenty-eight days this was so far complete that the normal vesicular murmur was present to the level of the seventh rib. . . . Save for a slight sinking-in of the chest-wall at the site of the resection of the ribs there is nothing to suggest the previous existence of an empyema."

Fowler formulates the following conclusions:

"1. Decortication of the lung is an operation adapted to all cases of old empyema in which extensive and preoperatively discoverable tuberculous lesions of the lungs are not present, and in which the patient's condition will permit of a major operation.

"2. It may be advantageously substituted for Estlander's operation. . . . .

"3. It should replace Schede's operation in all cases.

"4. The method by extirpation of the diseased portion of the pleural membrane, including the visceral, cortical, and diaphragmatic portions, is the operation of choice.

"5. Failing this, visceral pleurectomy should be selected.

"6. Pleurotomy, with simple detachment of the visceral layer of the diseased pleural membrane, gives sufficiently good results to warrant the surgeon in resorting to this procedure in cases in which the condition of the patient will not permit of the application of the other and more desirable methods.

"7. Whatever operative method is adopted, as complete access to the cavity of the chest as possible should be obtained, and rapid closure of the opening in the chest-wall afterwards secured, since the complete re-expansion of the lung must depend largely upon the normal respiratory movements.

"8. Pulmonary or respiratory exercises should not be neglected in the after-treatment. . . . . ."

Delorme in 1894 performed an operation very similar to that of Fowler ("Amer. Year-Book of Med. and Surg.," 1902), and did it successfully under spinal cocainization. Out of 29 cases of decortication by the Fowler method the functional results were 11 cured, 6 improved, 9 unimproved, 3 died; as regards the cure of the empyema, 17 were cured, 9 unimproved, 3 died.

Delorme has devised a method of temporary resection of the chest-wall, by forming and reflecting a flap consisting of the *whole* chest-wall; this being done, he decorticates the lung, cleans the empyema cavity, and replaces the flap of chest-wall, providing of course for drainage. This operation has not found much favor.

Roux in operating finds that a long incision through the indurated visceral pleura answers the same purpose as decortication.

Kocher in his work on empyemata is an opportunist; as the operation proceeds he finds out what has to be done and does it. If a fistula is present, he excises sufficient of one or two ribs in its location to permit of thorough exploration; if no fistula is present or if it is so situated that exploration from its site would be imperfect, he finds, by exploratory puncture, the lowest part of the empyema, and there resects one or two ribs. Guided by the finger in the cavity he enlarges his original incision in the soft parts backwards and upwards between the spine and the scapula to the uttermost limits of the empyema. Step by step he divides the ribs and intercostal muscles in the line of the skin-incision. If the empyema extends to the first rib, then the first rib must be divided. From the anterior end of the original incision, guided by the necessities of the case, the wound is en-

larged forwards and upwards and the corresponding portions of the ribs or costal cartilages divided. This flap, consisting of the whole thickness of the thoracic wall, can be reflected upwards sufficiently to expose the position of the lung and the condition of the visceral pleura. If an incision through the visceral pleura demonstrates that the lung can expand, Kocher proceeds to pulmonary decortication until the lung expands sufficiently to fill the cavity. If the lung does not expand or does so only partially, he now proceeds to subperiosteal resection of the ribs, attacking them from the deep surface of the flap (Depage's method). To obtain proper mobility in the flap it may even be necessary to excise the first rib—no easy matter because of the subclavian vein. If the indurated costal pleura prevents the application of the flap to the shrunken lung, then the offending pleura must be excised. If, after incision and decortication of the visceral pleura, the lung expands sufficiently to obliterate the empyema cavity, Kocher follows Delorme in replacing the osteoplastic flap, but provides for drainage by excising a small segment of rib through a special incision.

The after-treatment of cases in which any of the methods of thoracoplasty has been used is prolonged; often a year or more elapses before a cure is obtained, and during this time several subsidiary and plastic operations may be necessary. One would naturally expect that ultimately great deformity, especially scoliosis, would be present, and that the lung deprived of its thoracic wall would be useless. This is, however, not the case. Wonderfully little deformity persists; the lung expands and becomes a useful organ. In many cases there is a very evident reformation of ribs. As Karewski says, we must *not* be too sparing in removing large portions of ribs, especially in children, when this is demanded, as the lungs can still expand, and thus thoracic deformity may be avoided or reduced to a minimum.

OPERATIVE TREATMENT OF COSTAL TUBERCULOUS OSTEITIS AND OF THE RESULTING ABSCESSES.

The most common and least efficacious treatment of the above affection is incision, thorough scraping with a sharp spoon, and iodoformization. This treatment is often insufficient, and when we remember that the excision of a segment of a rib is easy and harmless, then we can have little hesitation in adopting more radical and effectual methods.

Let it be assumed that we have to treat an unopened abscess, not adherent to the skin, originating from a tuberculous focus in a rib. Cheyne recommends an operation on the following lines: Make a vertical or oblique incision through the skin over the abscess. The incision ought to extend at either end beyond the abscess itself. Retract the edges of the wound and dissect back the skin from over the abscess until the whole swelling is freely exposed. Instead of the above, a curved incision may be used and a more or less U-shaped flap of skin elevated to expose the swelling. If possible without rupturing the abscess, dissect it free from its surroundings except where it is attached to the offending rib. Expose the offending rib or ribs at each side of the abscess and subperiosteally divide them in such a manner that the whole mass, abscess cavity and rib, is removed *en masse*, leaving the posterior layer of periosteum *in situ*. On the normal cadaver this operation is difficult to do without puncturing the pleura, but in cases in which it is indicated, although caution must be exercised to avoid this accident, yet the accident is unlikely to happen, as the disease has caused thickening of the tissues. After removal of the abscess and segment of rib, examine carefully the remaining periosteum; if it is diseased, curette and swab it with liquid carbolic acid (neutralizing the acid by wiping with alcohol) or cautiously excise the diseased tissue. Attend to hemostasis and close the wound, after having provided for drainage. If it is impossible to excise the abscess intact, evacuate it either by incision and careful cleansing or by

aspiration or puncture. If aspiration or puncture has been employed, close the puncture in the abscess wall with a clamp or a purse-string suture before continuing the dissection. The same principles of treatment must be applied in cases of osseous disease with sinus formation.

When an infective disease, such as tuberculosis or typhoid, attacks one or more of the costal cartilages, repeated operations may be necessary before recovery takes place. Roux considered such cases almost incurable until he attacked them as follows: Through healthy tissue make an incision all around the focus of disease. Divide the skin, muscles, cartilage, and, if necessary, the bone. *When this cut has become sclerosed*, proceed to excise the disease. The wall of sclerotic tissue provided by the primary operation prevents spread of the disease in the now resistant cartilage ("Rev. de Chir.," Nov., 1904).

EXCISION OF TUMORS OF THE CHEST-WALL AND OF THE PLEURA.

Malignant tumors of the thoracic wall are seldom attacked unless—*e. g.*, in the course of an amputation of the breast—a tumor is accidentally found to be attached to the thorax, a state of affairs not known before the operation was begun. Parham has successfully removed a sarcoma of the chest-wall. Osteomata of the ribs ought, other things being favorable, always to be removed, because of the disastrous effects of their growth. The technique of the operation is very similar to that for the removal of tuberculous foci, and is along the following lines:

1. Make an incision all around the tumor, preserving as much skin as possible without cutting too near the disease.

2. Free the tumor from its surroundings, sacrificing all muscular tissue attached to it.

3. Subperiosteally divide all the ribs to which the tumor is adherent.

4. Note if the pleura is adherent to the tumor; if it is, then excise the adherent portions along with the tumor. Endeavor

to avoid the *sudden* entrance of air into the pleura. Let the primary opening into the pleura be small, so that the air enters slowly; with a moist pad of gauze close the opening at intervals so that the conditions of internal and external pressure may have time to adjust themselves. As the pleural wound is enlarged, progressively pack gauze (sterile) into the pleural cavity. The gauze packs shut off the rest of the cavity from the field of operation. Before the pleura is opened, warn the anæsthetist to let the patient come out of deep anæsthesia. Coughing on the part of the patient is now desirable, as the violent distention of the lung helps to guard against dangerous pneumothorax. When the packing of gauze has been thoroughly done, violent disturbances of respiration do not continue long. After the tumor has been removed, the gauze must be withdrawn and the lung, which is generally "coughed into" the wound, is caught and fixed to the thorax with a few stitches. This *pneumopexy* is of special importance when part of the lung demands removal.

When a segment of lung is affected by the tumor, it, of course, is adherent to it, and thus it is easy to apply sutures all around the diseased area.* Dollinger advises that pneumothorax be *slowly* produced the day prior to operation. Delageniere, after taking similar precautions, has operated for two hours in the open thorax without ill effect. The safety of slowly produced pneumothorax is evidenced by J. B. Murphy's work on phthisis pulmonalis. After removal of all the disease, even perhaps of part of the diaphragm, close the wound with sutures, providing efficient drainage.

If so much skin has been removed that complete closure is impossible, and if there has been no suturing of the lung to the thoracic wall (pneumopexy), part at least of the gauze packing

* v. Mikulicz and others have recently recommended that certain thoracic operations be carried out in a pneumatic cabinet. The surgeon, his assistant, and the patient's body are inside the cabinet, where the air-pressure is negative; the patient's head protrudes through the wall of the cabinet, his neck being surrounded by an air-tight collar. This procedure is suggestive and worthy of consideration.

must be left in place until adhesions form. In every case the dressings must be liberal, air-tight, and left undisturbed as long as possible. The lung soon expands, and air left in the pleura rapidly disappears. (The preceding description of excision of tumors is largely taken from Karewski's admirable clinical lectures.)

Pneumotomy.—Incision of the lung is demanded to provide for drainage in cases of pulmonary gangrene, abscess (whether tuberculous or pyogenic in origin), and large bronchiectatic cavities; also for the treatment of echinococcic cysts.

The abscess is carefully localized by the usual methods of physical diagnosis. The skin is cleaned over the site of the lesion. The long and delicate needle of an exploring syringe is pushed in the direction in which the pus is believed to exist. The needle ought to be attached to the syringe by means of rubber tubing which has been divided and reunited by the interposition of a small glass bulb or tube. When the point of the needle has penetrated the lung to the suspected area, slight suction is made with the syringe. If any pus is present, it will be noticed in the glass placed in the tubing. If no pus is found, make the needle penetrate more deeply and repeat the suction. After every change in the position of the needle make the suction test with the syringe. When the piston of the syringe has been pulled out to its full extent, clamp the rubber tube, detach the syringe, push the piston down, attach the syringe to the tube, remove the clamp, and proceed as before. It may be necessary to push the needle in various directions before the pus is found. Having found the abscess by the above means, leave the needle *in situ*. Make an incision parallel to the ribs and beside the needle. This incision should be at least three inches in length. Some surgeons at once expose the pleura at an intercostal space, but it seems wiser to provide more room by the subperiosteal resection of about two inches of the rib above and below the needle. Observe whether the pleura is adherent or not. If the pleura is adherent, using the needle as a guide, push into the lung the point of a thermocautery heated to a dull-red color. When the cavity is opened, withdraw the needle and cautery. If the cavity

contains loose gangrenous tissue or much solid débris, endeavor to remove it gently with a blunt curette or forceps. Introduce a large soft-rubber drainage-tube. The skin-wound may be partially closed by a few stitches.

Instead of using the cautery many surgeons open the abscess with a trocar and cannula, and either introduce the drainage-tube through the cannula or pass a closed forceps into the cavity alongside of the cannula, enlarge the opening by separating the blades of the forceps, push in the finger to explore the cavity, introduce the drain, and remove the forceps. In examining the cavity with the finger do not break down any bands crossing it. Abscess cavities have frequently been douched with antiseptic solutions without evil results, but as the gain to be obtained by irrigation is problematical, and as it has done harm, it is much better to omit lavage.

If, after subperiosteal resection of the ribs, the pleura is found to be non-adherent, adhesions must be provided, otherwise as soon as the pleural cavity is opened a dangerous condition of pneumothorax obtains. The formation of adhesions may be stimulated by the application of irritants, such as chloride of zinc, to the outer surface of the unopened parietal pleura. This is rather a blind method of reaching the goal. Most surgeons proceed somewhat as follows: A fully curved needle, armed with a thick silk or catgut suture, is passed through the *unopened* pleura, made to pick up as large a *bite* of the lung and visceral pleura as is possible, and brought out again through the parietal pleura. Much gentleness must be exercised in tying the sutures, as the pulmonary tissue is friable. From two to four sutures will generally be found ample to secure apposition of the two pleural layers. The parietal pleura is weak, therefore the sutures should catch other tissues as well. The sutures may be made to penetrate a large gauze pad (four thicknesses) laid on the outside of the chest, with an opening in the centre to permit of subsequent operation. The subsequent steps of the operation should be carried out, in the manner already described, after the lapse of a week.

Should the case be one of such urgency as to warrant incurring the extra risk, one must surround the diseased area by a row of interrupted "back-stitch" or interlocking sutures of catgut, uniting the parietes to the visceral pleura and lung. Do not take too deep a "bite" of lung with the needle. If pleural suturing is, from any cause, impossible, pack the pleural cavity as it is opened with gauze, as in the case of empyema. It has been claimed that aseptic silk sutures applied to the non-infected pleura do not produce enough irritation to ensure the formation of effective adhesions. Silk sutures soaked in turpentine have been employed and found to be satisfactory.

After the pus or the contents of the echinococcic cyst have been evacuated, provision must be made for drainage. This is best done by leaving the wound wide open and packing with sterile gauze (iodoform gauze is liable to lead to poisoning). Rubber tubes may be used *if surrounded by gauze.* Tubes unprotected by gauze occasionally cause erosion of blood-vessels. When there is much loss of lung substance and there is not sufficient compensatory distention of the remainder to fill the resulting void in the thorax, the treatment must be similar to that of old empyema, viz., resection of an appropriate amount of thoracic wall. Lung wounds heal slowly and form but few granulations. Epidermization progresses from the skin alone; any growth of epithelium from divided bronchi leads to persistent fistulæ being formed. As soon as retraction or dragging inwards of the external soft parts ceases to progress satisfactorily, recovery may be hastened by the use of skin-flaps obtained in the neighborhood. If bronchial fistulæ persist, they may be closed by the application of the cautery. It must be remembered, however, that a persistent bronchial fistula may be, in reality, beneficial, in that it gives vent to discharges which would otherwise be retained and cause serious trouble.

Pericardiocentesis.—This operation is indicated both as a means of diagnosis and of treatment. For diagnostic purposes we may use an exploring or hypodermic syringe provided with long needle; for purposes of treatment an aspirator is required.

When the pericardial effusion is non-infective, a cure may be obtained by simple paracentesis. In performing this operation, the fluid must be withdrawn slowly and the suction stopped, temporarily, whenever there is any pulmonary or cardiac distress. It is unnecessary and imprudent completely to evacuate the fluid. The usual site for introducing the aspirating needle is in the fourth or fifth intercostal space, one inch to the left of the sternum. A better position is in the sixth intercostal space immediately to the left of the edge of the sternum. This last position gives the greatest security against injury to the internal mammary artery, to the pleura, and to the heart itself.

EXPOSURE OF THE PERICARDIUM AND OF THE HEART.

When there is an infective exudate in the pericardium, operation is clearly indicated. The same is true in all cases of wound in the cardiac region when there is marked respiratory distress with cyanosis or there is collapse with anæmia and corresponding changes in the pulse, accompanied by the physical signs of pericardiac effusion. (Kocher.)

Many methods have been devised by which to expose the pericardium and heart; of these, Ware gives an excellent account in the "Annals of Surgery" (October, 1899), but almost all of them, *e. g.*, those of Podrez, Niuni, etc., assume that one desires to expose the whole pericardial sac in every case and that a lesser procedure will never be efficient. Such operations consist in the formation and reflection of large flaps consisting of the skin, muscles, costal cartilages, and sternum. They require much technical skill for their performance. Wounds of the pericardium and heart call for *immediate attention*, and no extremely difficult and unnecessarily complicated method should be taught. The type of operation here taught is that described by Kocher, and any practitioner of ordinary dexterity ought to be able to perform it, in emergency, with comparatively few and common

instruments. The operation has a further advantage in that no unnecessary exposure of the pericardium is called for.

Pericardiotomy.—(1) Make an incision down to the bone from the middle line of the sternum outwards towards the left side, at the level and following the line of the sixth costal cartilage. If required, the incision may extend to the left mammary line. (2) Separate the perichondrium and all the soft parts from the sixth costal cartilage and excise the cartilage. This exposes the triangular muscle of the sternum with the mammary vessels, which are ligated if necessary. Divide the tendinous insertion of the triangular muscle into the sternum. The dense, glistening pericardium now lies exposed, and if drainage alone is required, it may be opened and the operation is complete. If more room is required: (3) From the sternal end of the horizontal incision cut upwards in the midsternal line to the desired extent (usually to the level of the second rib). (4) Separate the periosteum and soft structures from the sternum to the left of the median line. Divide the fifth, fourth, and third left costal cartilages at their insertions into the sternum. (5) Through the horizontal wound push the exposed margin of pleura outwards. Gradually lift up the fifth and even the fourth and third costal cartilages, slowly and gently pushing back the pleura from their deep surface. (6) After separating the flap from the pleura fracture or divide the costal cartilages in the flap, at their junction with the corresponding ribs. When this is done, the flap can be completely reflected. (7) Split the pericardium along the sternal margin and laterally along the fifth interspace. This gives access to the heart from the auricles to the apex of the ventricles. If more room is desired, (8) excise a sufficient portion of the sternum by means of rongeur or bone forceps.

The pericardium being open, wipe away blood-clots which may be present; search for and suture with catgut or silk any cardiac wounds. Do *not* include in the suture a coronary artery. Close the pericardial wound with or without drainage. Suture or drain any pleural wounds which may be present. Don't waste time by trying to evacuate thoroughly blood from the

thoracic gullet, the œsophageal wall is caught with two forceps and divided between them over the body, which is removed with forceps. The œsophageal wound may or may not be sutured; certainly free drainage of the wounded posterior mediastinum is a necessity. Small, apparently localized, cancers of the œsophagus may possibly be excised after exposure in the above manner. Inflammatory lesions of the posterior mediastinum may be exposed by Nassilov's operation and subjected to proper surgical treatment.

PART III.—THE ABDOMEN.

CHAPTER I.

LAPAROTOMY; CELIOTOMY; ABDOMINAL SECTION.

METHODS OF OPENING THE ABDOMEN.

The patient, anæsthetized, is placed on the operating table. The limbs and chest are well protected with blankets. The operating room and table are well heated. The field of operation is cleansed and surrounded by sterile cloths or towels.

The classical method of opening the abdomen is by the median incision.

(**A**) **Median Incision.**—In the middle line, either above or below the umbilicus, make an incision through the skin and subcutaneous tissues. The length of the incision varies according to circumstances, but to begin with is usually about three inches. In the linea alba divide the firm structures constituting the *essential* belly-wall. As a rule, hemorrhage will be trifling and may be disregarded, but if any vessels bleed amazingly, apply clamps or ligatures before opening the peritoneum. Pick up a small fold of peritoneum in forceps and cautiously make a very small incision through it. When satisfied that the peritoneum is opened, catch each side of the peritoneal wound in a hemostat and by crossing the forceps, temporarily, close the belly until the hands can be once more rinsed, first in an antiseptic solution and then in water or salt solution. Enlarge the peritoneal wound; introduce the finger to explore. Enlarge the incision with scissors, if such enlargement is necessary to permit of the necessary operative procedures.

If it is necessary to enlarge the incision beyond the umbilicus, cut around that structure generally to its left side, or even excise it, since it is not suitable for suturing and it is impossible thoroughly to cleanse it.

(B) **Lennander's Method.**—Make a vertical incision a short distance to the right or left of the median line, exposing the anterior surface of the rectus. Incise the anterior layer of the rectus sheath. Retract the inner edge of the rectus outwards, exposing the posterior layer of its sheath, and incise that layer. Open the peritoneum. Note that the rectus muscle itself is neither incised nor split, and hence its nerve-supply is not injured in the slightest. In closing the wound, remember to suture each layer of the rectus sheath separately (Fig. 218). A similar incision may be made about three-fourths of an inch internal to the outer edge of the rectus, the sheath opened, the muscle retracted inwards, and the abdomen penetrated.

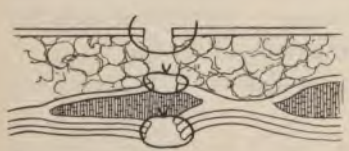


FIG. 218.

(C) **Vertical Incision through the Rectus.**—This incision is very common at present, especially in America. Make a vertical incision to one side of the median line down to and through the anterior layer of the rectus sheath. Split the rectus muscle by blunt dissection. Divide the posterior layer of sheath and open the abdomen.

(D) **Vertical Incision at the Outer Edge of the Rectus.**—This requires no special description.

(E) **Transverse Incisions.**—To avoid injury to the motor nerves of the abdominal muscles, Kocher strongly advises that transverse incisions be used in the upper half of the belly-wall when median ones are insufficient or unsuitable. On occasion, he combines the transverse and median so as to obtain more room. (See chapter on the "Gall-bladder.")

(F) **Oblique Incisions.**—In the lower half of the abdominal wall, when it is desired to operate remote from the median line,

incisions are recommended running obliquely from above downwards and inwards—*i. e.*, in the direction of the fibres of the external oblique muscle. Such avoid division of important motor nerves and permit of splitting instead of dividing the external oblique muscle. (See chapter on "Appendicitis.")

METHODS OF CLOSING THE ABDOMEN.

The great object to be attained in closing the abdomen is the prevention of subsequent hernia. In the attempt to gain this

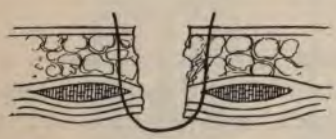


FIG. 219.

FIG. 220.

end, surgeons have adopted a vast number of methods of suture. A study of the annexed diagrams (Figs. 219 to 226) will explain the

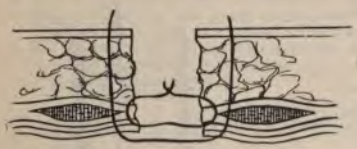


FIG. 221.

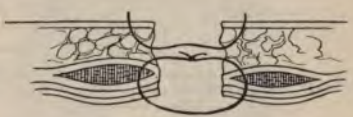


FIG. 222.

suture methods more clearly than any printed description. The buried sutures uniting peritoneum or fascia are best introduced

FIG. 223.

FIG. 224.

with full curved or short straight needles, and may be catgut, silk, silkworm-gut, or silver wire. The writer prefers some form of

catgut, either mildly chromicized or iodized. Kocher thinks silk the only proper material. In the Johns Hopkins clinic silver wire is used. Other surgeons prefer silkworm-gut, tendon, aluminum-bronze wire, etc. When properly used, each material does good

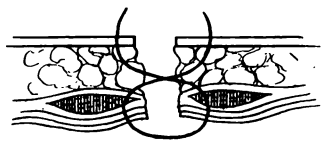


FIG. 225.

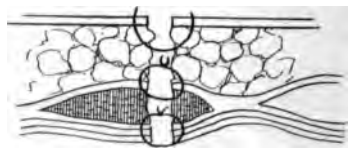


FIG. 226.

work. When "through-and-through" sutures are used—*i. e.*, sutures embracing in their loop the whole thickness of the belly-wall—some form of handled needle, such as Reverdin's, is most convenient and saves much time, but any good straight or

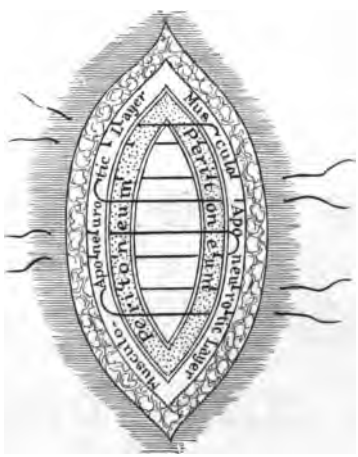


FIG. 227.—JONNESCO'S METHOD (MODIFIED).

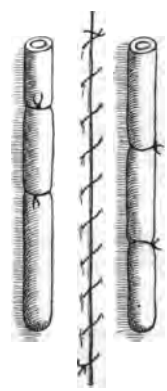


FIG. 228.

curved needle of proper size will suffice. Some surgeons, *e. g.*, Jonnesco, object to the use of absorbable sutures, of non-absorbable buried sutures, and yet desire to close the abdominal wound in layers. For this reason they have devised more or less com-

plicated means of suturing, so that they can remove the stitches when they have served their purpose (Figs. 227, 228, 229, 230).

The inexperienced surgeon, after completing a prolonged operation on an exhausted individual, sometimes forgets that it is better to have a post-operative hernia in a living patient than a perfectly closed wound in a corpse. Under some circumstances

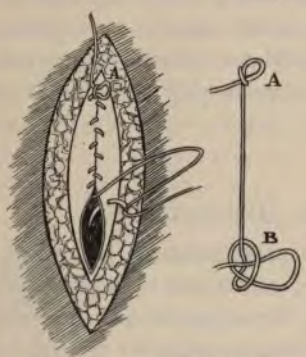


FIG. 229.—DAVISON'S METHOD.

A. Slip-knot to prevent suture being pulled through the tissues. The free end of the suture is left projecting from the wound, and when pulled upon unties the slip-knot and so permits extraction of the suture. B. Slip-knot tied when suture is in place. Untied the same way as A.

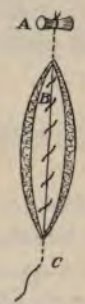


FIG. 230.

Continuous sutures fixed by pad of gauze at A.

it is wise to put in as few stitches as possible, and these in the quickest manner possible.

When drainage has been used, it is good practice to place sutures in position for the closure of the opening left by the removal of the drain and tighten and tie these subsequently.

POSITION OF PATIENT DURING OPERATION.

In most abdominal operations the ordinary dorsal position suffices. Frequently, when the lower part of the belly is invaded, it is of enormous advantage to have the intestines well out of the way; this advantage is obtained by elevating the pelvis and depressing the shoulders (Trendelenburg's position). The angle of inclination may be as much as 45 degrees. In the region

of the gall-bladder the intestines may be kept out of the way by placing a sand-bag about five inches in diameter under the back, opposite the lower dorsal vertebræ.

DRESSINGS.

After completion of the operation, cover the wound with a number of pads of sterile absorbent gauze; over these place a liberal quantity of sterile absorbent cotton. Keep the dressings in place with a binder, or preferably by strips of adhesive plaster.

ABDOMINAL OPERATIONS.

Before describing the individual operations performed on the gastro-intestinal canal it will be convenient to consider the means at our disposal for preventing the escape of its contents from an incised gut and of closing intestinal openings by means of sutures. Some special methods of suturing will be described later, along with the operations for which they were devised.

FIG. 231.

Preparation of a Loop of Gut for Incision.—With the finger and thumb express the contents of the selected portion of gut either upwards or downwards so as to leave that portion empty. Prevent the return of the contents to the loop of gut by appropriate clamps, applied above and below. When available, the best clamps are the fingers of an assistant exercising pressure on the gut. The objections to this are that the fingers are liable to take up too much room, and that the hands of the assistant become so fatigued that he can give but little assistance during the rest of the operation. If plenty of help is at hand, of course the latter objection loses its weight.

Murphy's clamps (Fig. 231) are excellent. It is entirely unnecessary to protect the blades of this clamp with rubber tubing.

Pean has suggested a most convenient intestinal clamp (Fig. 232) and one which is always ready. To the proximal side of the catch of an ordinary hemostatic forceps tie the end of a soft-rubber catheter or piece of drainage-tube. Pass the point of the forceps behind the gut and through the mesentery close to the gut. Open the forceps. Place the free end of the rubber tubing over the front of the gut; stretch the tubing and catch it in the jaws of the forceps. The result is that the gut is clamped by the rubber in front pressing towards the forceps behind.

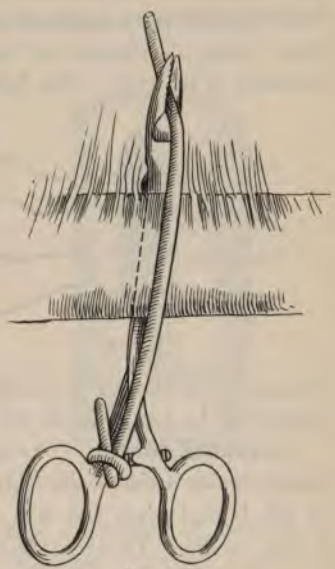


FIG. 232.

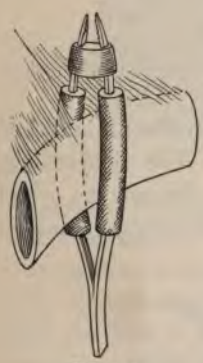


FIG. 233.

Passage of intestinal contents may be stopped by tying around the gut strips of gauze or pieces of coarse silk or catgut. Of course, before they can surround the gut they must perforate the mesentery. Do not tie such materials tightly, as little pressure is necessary and much is injurious.

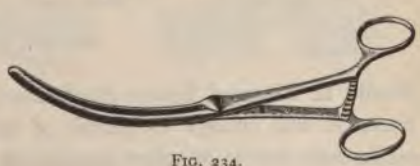


FIG. 234.

Maylard extemporizes an excellent clamp by covering the blades of a dissecting forceps with rubber tubing. When the blades have been made to grasp the intestine, their points are kept together by a segment of tubing slipped over them (Fig. 233). Doyen's clamps are much used in operations upon the stomach (Fig. 234). The blades must be covered with rubber

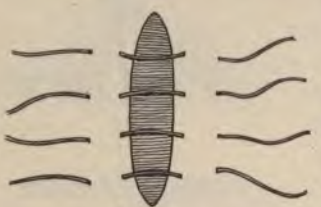


FIG. 235.

FIG. 236.

tubing. The number of clamps invented is legion, but those mentioned will be found ample for all purposes.

Intestinal Suture.—The most common material for intestinal suture is fine twisted silk—preferably black. The disadvantage of silk is that when wet it is difficult to pass through the eye of a fine needle. To avoid this difficulty a sufficiency of needles

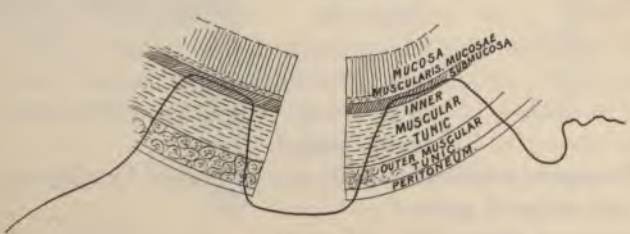


FIG. 237.

should be threaded before sterilization is begun. Fine celluloid hemp is stiff enough to permit of being threaded on a needle while wet, and is in other respects as satisfactory as silk, hence is preferable. The best needles are the ordinary seamstress's needles, about one and a quarter inches in length. Various curved needles (without any cutting-edge) are useful and may be ob-

tained in any good instrument store. The intestinal wall consists of the following tunics: the serosa, the musculosa, the submucosa, and the mucosa. The submucosa is the firm, thin tunic which is used in making sausages. It provides the most reliable hold for a suture.

FIG. 238.—(*Monod and Vanverts.*)

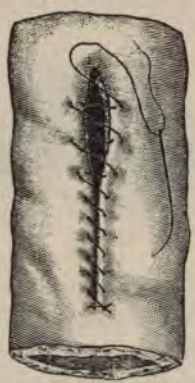


FIG. 239.—(*Esmarch and Kowalzig.*)

Lembert Suture.—This is the basis of almost all methods of intestinal suture. Its aim is to close an intestinal wound by turning the cut edges inwards and bringing the serosa of one side into apposition with that of the other side. Halsted has shown that it is wise to include the submucosa in the stitch. When a *not* too sharp needle is introduced through the serosa and muscu-

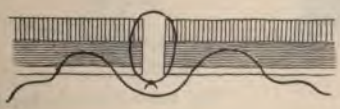


FIG. 240.

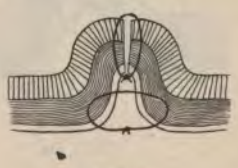


FIG. 241.

losa, its advance is easy, but when it reaches the submucosa, a slightly increased resistance is perceptible. It is then easy to pick up some of the submucosa on the point of the needle. The introduction of the suture is sufficiently shown in Figs. 235, 236, and 237.

Halsted's Quilted Suture.—This is in principle identical with Lembert's. The suture is introduced after the **U** fashion (Fig. 238).

Dupuytren's suture (Fig. 239), or continuous Lembert, can be easily and quickly applied, and when properly used, is a most excellent procedure. In America it is curious to notice that most

FIG. 242.

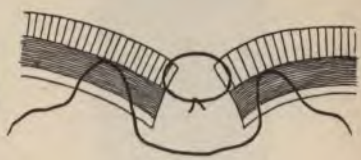


FIG. 243.

eastern operators use the interrupted suture, while the westerners favor the continuous. The results seem as good whichever method is employed; hence the continuous being the easier to apply, it seems to the author to be the better. It is important to observe the blood-vessels running towards the wound in the gut, and to pass the needle under such, so that when the edges of the wound are inverted by the tightening of the sutures, these constrict the

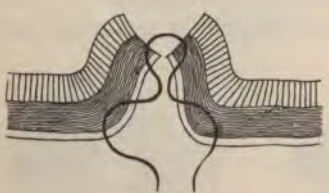


FIG. 244.

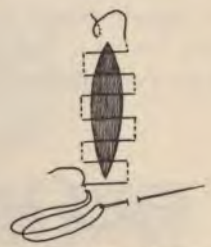


FIG. 245.—CUSHING'S SUTURE.

vessels and so prevent hemorrhage. If one fears that a continuous suture will act as a purse-string and cause contraction, one may obviate this danger (if danger it be) by occasionally interrupting the suture by fixing it with a knot (interrupted continuous suture).

Several methods of closing an intestinal wound by different layers of suture have been devised. Some of these are illustrated in Figs. 240, 241, 242, 243, 244.

Through-and-through Sutures.—When closing a wound or uniting divided ends of gut there is often considerable hemorrhage and some danger of the line of Lembert sutures becoming infected by intestinal contents. To control hemorrhage nothing is better than to unite the edges of the wound with a continuous stitch of catgut or silk penetrating all the thickness of the gut-wall. This line of suture is at once covered and hidden by a row of Lembert or Dupuytren sutures, and serves to protect the latter from infection. Cushing's and Gely's methods of suture are sufficiently explained by Figs. 245 and 246.

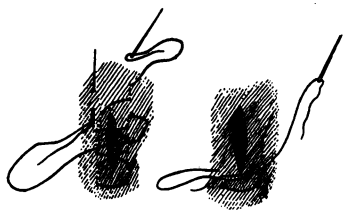


FIG. 246.—GELY'S SUTURE.

CHAPTER II.

THE STOMACH.

Exploratory Operation on the Stomach.—At least one day prior to operation thoroughly wash out the stomach with warm water. Repeat this lavage immediately before the operation. Be careful to empty the stomach completely. If the stomach has been for a long time much dilated, do not empty it during the first lavage. Under these circumstances preparation should consume several days. If the organ is suddenly or rapidly cleaned, tetany is very liable to develop. In dehydrated patients, *i. e.*, those who pass not more than 500 c.c. of urine in twenty-four hours, it is of vital importance to give hypodermically from 40 to 60 ounces of saline solution per diem for several days before operation. When diseased, the stomach almost always lies at a lower level than in health, hence the incision need not be so near the ensiform cartilage as might be imagined from a study of normal anatomy.

Having opened the abdominal cavity, introduce the finger and palpate the stomach and its surroundings. This is often sufficient for diagnosis. If it is not sufficient, pull the stomach into the abdominal wound, surround it with warm pads, and inspect the anterior gastric wall. If a pyloric stenosis is suspected, invaginate a part of the stomach-wall with the finger so that the finger penetrates and palpates the pylorus. Gentleness must be employed. If it is desirable to explore the interior of the stomach, *e. g.*, for ulcers, pack the abdominal cavity around the stomach with warm gauze pads. It is universally advised to count the pads before beginning the operation. This is a good rule. A rather better precaution against losing and leaving a pad in the belly cavity is to have 6 inches of soft tape sewed to each pad,

and as the pads are introduced into the belly to let the tape emerge from the wound and be anchored by a hemostat. The tapes emerging through the wound are never in the way. The writer makes it a rule never to place a pad in the abdomen without an anchor affixed, and never to use other pieces of gauze for sponging inside the cavity unless they are held in sponge forceps. These rules are simple, and hence efficient.

Make an assistant pick up a fold of the anterior wall of the stomach. Incise this fold in a direction at right angles to the long axis of the organ. If there is fluid in the stomach and its walls are not weakened too much by disease, introduce a blunt tube and empty the viscus. Introduce the finger into and palpate the stomach. Retract the edges of the wound and inspect the interior. In doing this a rectal speculum provided with a diaphragm and 2½ inches long by 1½ in diameter is of great aid and permits inspection of the duodenum through the pylorus. Close the gastric wound by sutures of catgut involving the whole thickness of the wall; this row of sutures to be inverted or buried by a series of Lembert or continuous Lembert stitches. Close the abdomen. Some surgeons make use of sutures involving the whole thickness of the belly-wall; the author much prefers to unite the different layers separately with catgut, reinforced perhaps by a few silkworm-gut stitches involving the whole thickness of the abdominal wall except the peritoneum. Return the patient to bed. Keep him warm.

Thirst, and later hunger, may be relieved by warm water or nutrient enemata. If possible, do not give anything by the mouth for at least twelve hours, and then only water. Remember that the danger arising from giving drink or food by the stomach in such cases is really *not* from its leaking through the wound, but from vomiting being set up by its presence, and also from its stimulating effect giving rise to peristalsis, etc. Hypodermoclysis is of inestimable value in these cases. It is desirable that the stomach rest until repair is advanced. If there is much pain, morphine in an efficient dose should be given. If possible to avoid the use of morphine without cruelty, do so, but when its employ-

ment is decided on, administer in one dose enough to insure the effects desired.

Exploratory operations are strongly indicated "in cases of rapidly developing cachexia and emaciation with the symptoms of chronic gastritis and absence of HCl. Tentative treatment should not be prolonged over three weeks. It is not near so serious a fault to have caused the opening of a stomach and found nothing operable, as to permit a case to continue and find out at the autopsy only that it was a circumscribed carcinoma, the removal of which might have prolonged life for years." (Hemmeter, "Dis. of Stom.," p. 358.)

Operation for Ulceration of the Stomach.—It is tempting to advise operation in acute cases of ulceration where there is a copious hemorrhage, but recovery generally ensues under medical treatment and operation is proper only when the hemorrhage is not merely copious, but recurrent. Moynihan advises strongly against any search being made for the bleeding point; a gastro-enterostomy will cause all hemorrhage to cease and permit the ulcer to heal. In all forms of non-malignant gastric ulcer that surgeon finds the above operation entirely satisfactory. In all cases of chronic gastric ulcer with hemorrhage operation is indicated. When ulcer gives rise to gastric dilatation, to hour-glass stomach, or to gastralgia and dyspepsia, operation is called for; in fact, inveterate dyspepsia warrants operation after the failure of a fair trial of medicinal means of treatment.

In cases of uncomplicated ulcer Mikulicz recommends medical treatment unless the disease is very persistent or recurrent, when operation is proper, especially among the working classes. In other non-malignant affections of doubtful origin, notably those of a nervous character, he considers operation improper.

Whenever there is perforation of the gastric wall from ulceration, operation is imperative. Excision of the ulcer is unnecessary. All that is necessary is to close the ulcer with a single stitch of catgut and to infold the ulcer and a portion of healthy stomach with two rows of continuous Lembert sutures. (Moynihan.) If there has been much soiling, flush the cavity; "if the operation

is done within ten or twelve hours, a gentle wiping of the surrounding area with wet swabs will suffice. Drainage, as a rule, is not necessary, except in the late cases. When adopted it should be free, a split tube and a gauze wick being placed in the original incision and in a second suprapubic opening." Do not be content with finding and closing one perforation: look for more. In 20 per cent. of cases perforations are multiple.

In the preceding remarks no account has been taken of the presence of adhesions, or of scars and stenoses resulting from ulceration. Adhesions are nature's means of protecting the peritoneal cavity from general infection, but while immediately life-saving, they are very liable to occasion much gastric disturbance, and certainly make operative interference much more difficult. The mere breaking-down of gastric adhesions (gastrolysis) often suffices to cure apparently inveterate cases of dyspepsia. Mayo Robson ("Transactions Am. Surg. Association," xix) has carried out this treatment fifty-six times with complete success. Before closing any perforation or before uniting bowel to stomach, if adhesions exist, they must be so broken down or divided that the parts to be united tend to lie together, and the sutures when inserted keep the parts together *without any tension. Tension on sutures is fatal.* The technical difficulties occasioned by adhesions may dominate the choice of operation for the relief of ulcer or its sequelæ. Ulcers are most commonly situated posteriorly in the pylorus and the pyloric half of the lesser curvature. Four-fifths of all ulcers are in this limited region.* It is very commonly accepted that chronic gastric ulcers may and do act as the starting-point of malignant disease. It is known that ulcers are often multiple. Influenced by the above considerations, Rodman has suggested the advisability of excising the pylorus and that portion of the stomach most commonly the seat

*Forty per cent. of ulcers are in the posterior wall of the body of the stomach; 25 per cent. in the pyloric portion; 15 per cent. on the lesser curvature; only 20 per cent. affect the anterior wall, but these furnish 80 per cent. of all the perforations ("Handbuch der praktischen Chirurgie," iii, 292).

of ulceration. In this he has the support of the Mayos. The lines of incision advised by these surgeons are shown in Fig. 247.

The presence of ulcers or of their sequelæ is the most common occasion for operations on the stomach. One must remember that there are two forms of non-malignant gastric ulcer: (*a*) Those tending to perforate, involving all the coats of the stomach and easily recognized from the induration and sclerosis present; (*b*) those involving the mucosa alone, causing hemorrhage, etc., and yet not to be discovered before the stomach itself is opened, and even then with difficulty. The lesion is often more an erosion than an evident ulceration, and such cases have often led the surgeon to think he has been guilty of a serious mistake in diagnosis. When ulcers are present, the lymph nodes corresponding to the diseased area are generally enlarged and form a good guide to the location of the disease.

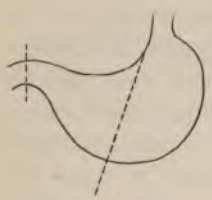


FIG. 247

Gastrostomy.—The object of gastrostomy is to make a convenient fistula into the stomach through which nourishment can be administered. Œsophageal stenosis is *the* indication for the operation, hence we have usually to do with emaciated and weak patients. The simplest method of operating is the worst. It consists in performing an exploratory gastrotomy and suturing the stomach wound to that in the parietes. The objection to the above method is that it permits a constant escape of the gastric juices. All the other methods of gastrostomy are attempts to avoid the above-mentioned fault.

(A) *Gastrostomy with Formation of Sphincter* (Hartmann; Terrier; Jaboulay, etc.).—By percussion and palpation define the lower edge of the liver in the epigastrium.

Step 1.—Make a vertical incision 1 to 1½ inches to the left of the median line, beginning at the lower edge of the liver and running downwards for about 2½ to 3 inches. Divide the anterior layer of the muscular sheath and split the rectus itself, but do *not* yet divide the posterior layer of the sheath.

Step 2.—Retract the wound inwards and thus expose the posterior layer of the rectus sheath and divide it along with the peritoneum near the median line.

Step 3.—Introduce the finger and pass it up under the left lobe of the liver to the portal fissure, and follow the gastro-hepatic omentum to the lesser curvature of the stomach. (Maylard, "Surgery of the Alimentary Canal.") This avoids all danger of mistaking colon for stomach. Pick up the anterior wall of the stomach and pull a cone of it through the wound. Close all the excess of peritoneal wound.

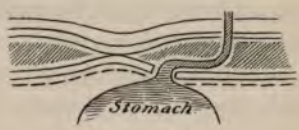


FIG. 248.

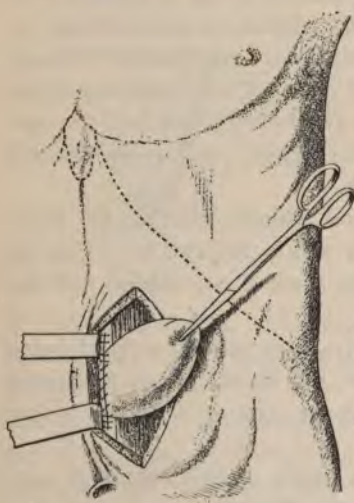


Fig. 249.

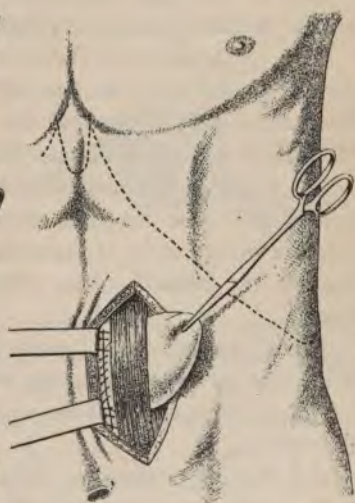


Fig. 250.

FIGS. 249 AND 250.—(*Monod and Vanverts.*)

Step 4.—Remove retractors and permit the rectus muscle to resume its normal position (Fig. 248).

Step 5.—Close all excess of abdominal wound and suture the protruding cone of stomach to the skin. Open the protruding portion of stomach and introduce a soft catheter into it.

Steps 1 and 2 may be varied as follows: Divide the anterior layer of rectus sheath along the line of the skin-incision; retract it inwards, *i. e.*, to the right; retract the whole rectus muscle outwards, exposing and dividing the posterior layer of sheath and the peritoneum near the median line; pull out the cone of stomach; split the rectus muscle along the line of the skin-incision and separate the internal portion from its posterior layer of sheath; pull the cone of stomach through the bridge of muscle thus formed and suture to the skin (Figs. 249, 250).

(B) *Frank's Operation.—Step* 1.—Beginning near the lower edge of the liver, make an incision downwards and towards the left, parallel to and one inch below the left costal cartilages. Length of incision, 2 to 3 inches.

Step 2.—Through the incision pull out a cone of stomach from as near its cardiac end as is possible without too much tension.

Step 3.—Make a second skin-incision, about 1½ inches in length, parallel to the first and situated over the left costal cartilages. Undermine the skin between the two incisions and pull the cone of stomach through the tunnel thus formed. Suture the stomach to the skin at the second incision.

Step 4.—Close the first wound without exerting too much pressure on the cone of stomach which traverses it. Open the apex of the stomach cone. The result is an oblique valvular fistula.

Frank's operation has the disadvantage that, the stomach being small, the peculiar formation of the fistula causes a deformity which seriously interferes with the carrying on of the normal functions.

(C) *Witzel's Operation.*—The object of this operation is to form an efficient fistula between the stomach and the skin and to make it oblique, so as to prevent leakage of gastric juices. In time the obliquity is lost, but yet leakage does not take place.

The Operation.—Open the abdomen through the rectus muscle by a two-inch vertical incision to the left of the middle line. From the junction of the body of the stomach and its pyloric portion pull into the wound a fold of the stomach near

the greater curvature, and here make a small incision, about the calibre of a lead-pencil, through the serosa and musculosa. Pick up the mucosa with forceps and open the stomach cavity. Take a soft-rubber catheter, about No. 25 Fr.; close one end of the catheter or tube with a clamp and introduce the other end into the stomach. Fix the tube to the gastric wound with one or more catgut sutures. Lay the proximal portion of the tube on the surface of the stomach and bury it by a row of Lembert or continuous Lembert sutures, as shown in Figs. 251 and 252. This forms a canal in the stomach-wall. The canal should be $1\frac{3}{4}$ inches in length or longer. Unite, with sutures, the outer opening of the canal to the parietal peritoneum. Bring the free portion of the tube out through the abdominal wound. Close the excess

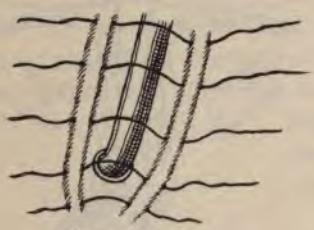


FIG. 251.

FIG. 252.

of abdominal wound. Over the portion of the tube external to the abdomen slide a short segment of a larger tube fitting snugly to the main tube. This outer ring of tubing is pushed up to beside the skin, and through it is passed a safety-pin to prevent the drain from penetrating too far into the stomach. If the safety-pin was introduced into the main tube, stomach contents could leak out alongside of it and irritate.

(D) *Stamm-Kader Operation.*—Expose and open the stomach as in the Witzel operation. Introduce a rubber tube and, with catgut, suture the edge of the gastric wound to the tube. With celluloid hemp or silk suture the gastric serosa, about $\frac{1}{4}$ inch distant from the wound, to the side of the tube all around it a short distance from the wound (Figs. 253 and 254). Insert

a second row of these serous sutures. This causes an inversion or invagination of the stomach-wall, which serves as an efficient valve. With Lembert sutures unite the stomach around the tube to the parietal peritoneum. Bring the outer portion of the tube through the abdominal wound at a convenient point. Close the excess of abdominal wound. The Stamm-Kader operation is the only one applicable when the stomach is much diminished in size. It is an excellent, perhaps the best, method of operating.

After-treatment.—It is better to administer nourishment per rectum for a few days after the operation, lest vomiting be set

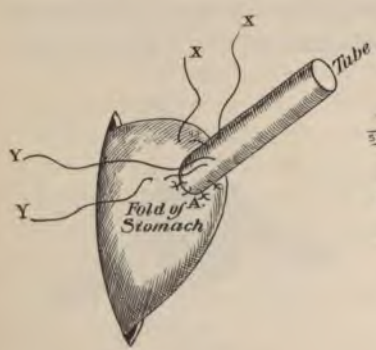


FIG. 253.

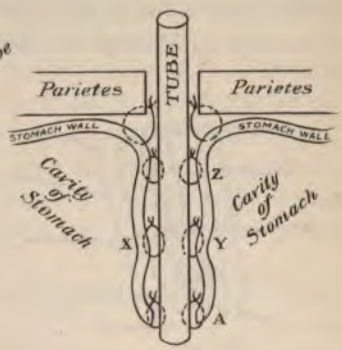


FIG. 254.

up. If the patient is urgently in need of nourishment, it may, however, be at once introduced by the catheter into the stomach. For weeks after operation the diet should be liquid; later solid food well broken up or chewed by the patient may be permitted.

Gastroplication.—This operation is occasionally performed in cases of gastric dilatation. It is exceedingly simple and has for its object the diminution in size of the stomach.

Step 1.—Expose the stomach by a vertical incision.

Step 2.—Into the anterior surface of the stomach introduce several rows of exaggerated Lembert sutures or some modification thereof. The result is an invagination of segments of the stomach-wall and consequent decrease in calibre (Fig. 255).

This operation is not curative, in that the cause of the trouble is not touched, and relapse is the rule.

Gastropexy.—This operation has been performed when, on account of gastroptosis, the patient has become a chronic invalid; suffers severely; is much emaciated, and none of these conditions is satisfactorily relieved by the ordinary non-operative methods of treatment. The object of the operation is to restore the stomach to, and retain it in, its normal position, and thus prevent dragging upon the gastro-hepatic omentum and pressure upon the intestines and pelvic organs, as well as obstruction to the onward passage of food from the stomach offered by kinking of the duodenum. The condition present is usually one of general visceral ptosis, hence the operation is commonly futile.

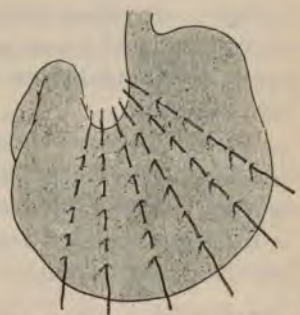


FIG. 255.—GASTROPLICATION.—(*Monod and Vanverts.*)

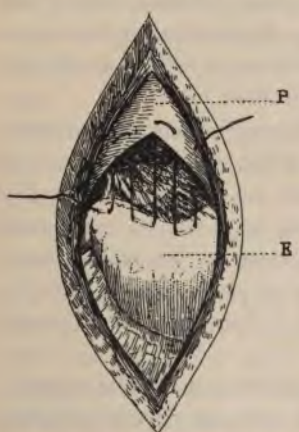


FIG. 256.—DURET'S GASTROPEXY.—(*Monod and Vanverts.*)

Duret's Operation.—Step 1.—Make an incision in the median line. Open the peritoneum and expose the stomach in the lower part of the wound. Expose but do *not* open the peritoneum in the upper part of the wound.

Step 2.—Insert a continuous suture on the modified Lembert plan, so as to unite the stomach and upper undivided portion of peritoneum. When this suture is in place, make both ends of it penetrate the fibro-muscular belly-wall and tie them there (Fig. 256).

Step 3.—Close the wound.

Rovsing's Operation.—Step 1.—Make a median incision from the ensiform cartilage to the umbilicus.

Step 2.—With the finger pull the stomach upwards to its normal level. Examine the pylorus for stenosis, etc.

Step 3.—Introduce fairly stout silk sutures as in Fig. 257. Do not tie them until the surfaces of the stomach and parietal peritoneum are scarified where they are to be apposed and the belly-wall is sutured.

Step 4.—Close the abdominal wound and place on it a pad of gauze. Over the gauze pad tie the sutures suspending the stomach. These sutures are left *in situ* for three weeks.

The operation is not dangerous and has given some strikingly brilliant results. ("Archiv f. klin. Chir.," lx, 816.)

FIG. 257.—ROVSING'S GASTROPEXY.

Gastropexy (*Beyea's operation*) has been accomplished by means of shortening the supports of the stomach. The lesser omentum is thrown into transverse folds, which are rendered permanent by a few sutures. In introducing the sutures be careful not to include any blood-vessels in their bite.

Gastrectomy.—(A) *Partial gastrectomy* is indicated in cases of limited and well-localized tumors of the stomach-wall, as well as in some cases of ulceration. After the removal of the diseased tissue the wound is to be closed by a line of continuous sutures, either involving the mucosa alone or the whole thickness of the stomach-wall. This line of deep sutures is to be buried by one or sometimes two lines of Lembert or continuous Lembert sutures.

(B) *Complete gastrectomy* is indicated when the whole stomach is affected by malignant disease, or if only one part is evidently affected, the rest is in a suspicious condition. It is useless to attempt a complete gastrectomy if neighboring structures are involved. Schlatter was the first to perform this operation; his patient died one year afterwards from recurrence.

The Operation.—Open the belly in the middle line by an incision extending from near the ensiform cartilage to the umbilicus. Divide the greater and lesser omenta after securing their vessels by chain ligatures. The stomach remains attached to the body by the œsophagus and duodenum. Pull the œsophagus downwards as far as possible and apply a clamp to it at as high a point as can be reached. Clamp the cardiac orifice of the stomach. Divide the œsophagus between the clamps. Apply two clamps to the pyloric end of the stomach or to the duodenum and divide between them. Remove the stomach. Close the open end of the duodenum by a continuous through-and-through suture covered by a row of Lembert sutures, interrupted or continuous. Approximate a loop of jejunum to the open end of the œsophagus. Anastomose the œsophagus and the portion of gut selected by suture or by the Murphy button. Of course, if the open end of the duodenum can be approximated to the œsophagus without undue tension, then these structures ought to be united. (Harvie, "Annals of Surg.," 1900, p. 344.) The technique of the operation is very similar to that of pylorectomy; in fact, the latter operation generally includes the removal of so much of the stomach that its designation is almost a misnomer.

Gastro-enterostomy, or anastomosis between the stomach and intestine, is indicated in cases of pyloric obstruction, gastric dilatation, and ulceration. According to the portion of intestine selected for anastomosis, the name "gastro-duodenostomy" or "gastro-jejunostomy" may be used.

According to whether the gut is united to the anterior or to the posterior wall of the stomach, the operation is designated "anterior" or "posterior gastro-enterostomy."

Wölfler's Operation.—Anterior Gastro-enterostomy.—The preparation of the patient is the same as in exploratory gastrostomy.

Step 1.—Open the abdomen by an incision in or near the middle line, between the umbilicus and the ensiform cartilage. The cut is about four inches long and may be enlarged by a transverse section of the rectus.

Step 2.—Expose the small intestine by pulling the omentum upwards and to the left. Find the jejunum by the method described on pages 251 and 254. Empty the loop of gut and apply clamps to keep it empty.

Step 3.—On the lowest possible point of the anterior wall of the stomach select a spot for the stomach opening (Fig. 258, *a*).

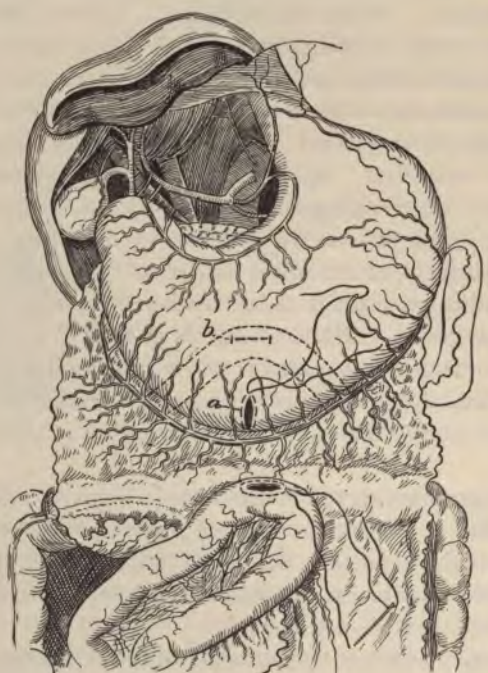


FIG. 258.—(*Mayo.*)

Pull this portion of stomach and the loop of jejunum out of the belly and protect the cavity with gauze pads. Make an anastomosis between the stomach and the jejunum, using either sutures or the Murphy button. The method of making the anastomosis is identical with that of entero-enterostomy (page 275).

Step 4.—Cleanse the field of operation. Put aside all instru-

ments which have touched the mucosa. Inspect the line of union, and if necessary reinforce it with a few Lembert sutures. If the point of union causes the intestine to kink sharply, this may be remedied by a few stitches uniting to the stomach a little more of the afferent or efferent portions of gut or of both.

Step 5.—Close the abdominal wound. The after-treatment is the same as for exploratory gastrotomy.

Kocher's Gastro-enterostomy.—Step 1.—Expose the stomach by a median incision down to or around the left side of the umbilicus. Examine every part of the stomach for disease or complications. (This thorough examination of the stomach ought never to be

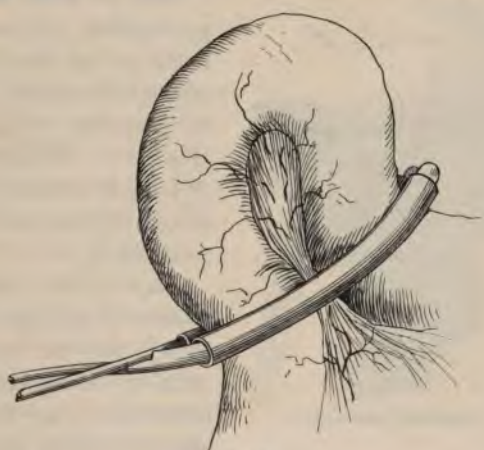


FIG. 259.

neglected, as complications, *e. g.*, hour-glass contraction, etc., may exist and render an otherwise perfect operation entirely useless.)

Step 2.—Find the lowermost part of the stomach; usually this is at the lowest point of the dilated pyloric portion. At this point separate the gastrocolic omentum, and with it the gastro-epiploic artery, from the stomach for about two inches. A few vessels will require ligation before division.

Step 3.—Throw the transverse colon upwards and hold it on the stretch. Seek the "plica duodeno-jejunalis" along the meso-

colon just to the left of the spine. At this point hook up the jejunum with the finger and trace it down for about 16 inches. Empty this portion of its contents and clamp in the usual fashion. Kocher uses a Doyen clamp applied to the gut, as in Fig. 259, and another applied to a fold of the stomach at the point of anastomosis. These prevent extravasation of contents and effusion of blood.

If one fears the effect of the Doyen forceps on the gut-wall and on the circulation, one may clamp the intestine above and below by a ligature or tape and not interfere with its vascular supply at all; under such circumstances the fold of the stomach is clamped by the fingers of an assistant.

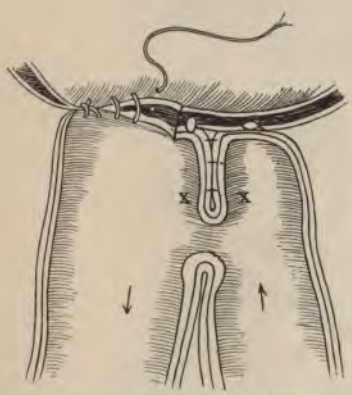


FIG. 260.—MODIFIED FROM KOCHER.

Step 4.—Place the loop of gut against, and at a right angle to, the stomach. The afferent portion of gut must be posterior to the efferent (Fig. 261). Choose the part of the gut at which to make an opening into it, but do not yet incise it.

Step 5.—In the afferent portion of gut, near the place chosen for the anastomotic opening, invaginate its wall transversely, on the convex side of the loop, and equal in extent to one-half its circumference (Fig. 260, x, x). A few Lembert sutures make this invagination permanent.

Step 6.—Suture the gut along the line of invagination to the stomach, *posterior* to the greater curvature and just behind the spot chosen for the anastomosis. (This is rendered possible by the separation of the gastrocolic omentum noted in Step 2.) The effect of this procedure is to create a "spur" in the afferent portion of the intestine, which will prevent the reflux of stomach contents into it when the anastomosis is completed; it also unites the gut to the stomach.

Step 7.—Just in front of and parallel to this line of invagination unite the stomach to the gut by a continuous Lembert (Dupuytren) suture (Fig. 261). This is the posterior line of serous sutures. In front of the posterior line of serous sutures incise the stomach down to but not through its mucous coat, and close to the greater curvature. (In Fig. 261, for the sake of clearness, the opening in the stomach is made at too high a level and that in the gut is too much curved.) Make a corresponding and similar incision in the intestine; be sure that the intestinal incision is transverse. With a continuous suture unite the serosa and musculosa of the posterior edge of the wound in the stomach to that in the gut, and with the same thread unite the gastric to the intestinal mucosa after incising these structures. Unite the remainder of the circumference of the gastric to the corresponding portion of the intestinal opening by through-and-through continuous sutures. Cleanse the line of suture and its neighborhood, and complete the anastomosis by continuing the posterior line of serous sutures around the front until all the deep, through-and-through sutures are entirely buried. It is very important to have the opening in the stomach as large as possible; thus it is made a little larger than that in the gut, which is equal to half the circumference of the intestine.

FIG. 261.—(*Kocher.*)

Posterior Gastro-enterostomy.—*v. Hacker's Operation.*—The operation as performed by Moynihan is ideal, and will be described. It is hardly necessary to remark that the Murphy button may be used in place of the sutures.

Step 1.—Expose the stomach by an incision three-fourths

of an inch to the right of the median line. Examine *the whole* stomach and duodenum. No matter what condition is apparent at the first glance, there may be something else present, *e. g.*, a trifid stomach, which it is necessary to recognize.

Step 2.—Lift the transverse colon and great omentum out of the abdomen and turn them up over the epigastrium. Expose the under surface of the transverse mesocolon. Choose a bloodless spot in this structure and tear through it. Have the assistant push the posterior wall of the stomach through this opening. Catch a fold of the protruded posterior wall of the stomach, three inches in length, in the blades of either a Doyen hysterectomy or intestinal clamp (blades protected with rubber tubing).* Apply the clamp in such a way that the portion of stomach embraced by it extends from the greater curvature obliquely upwards to the lesser curvature and towards the cardia.

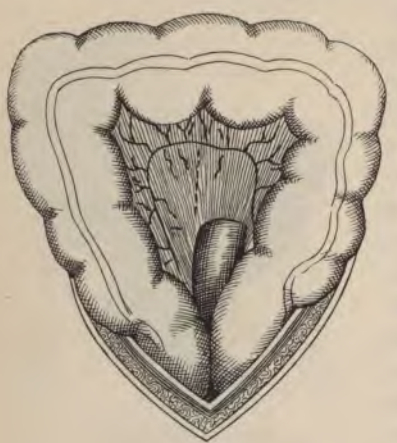


FIG. 262.

Step 3.—When the transverse colon is pulled firmly upwards, the jejunum is at once seen coming through the opening in the transverse mesocolon (Fig. 262). This is the simplest means of finding that portion of the gut. Moynihan finds the duodeno-jejunal angle by sweeping the finger along the under surface of

*The ordinary Doyen hysterectomy clamp is really too short in the blade for this purpose, and has given the author much annoyance when operating. A specially long-bladed clamp is now procurable and answers every purpose admirably.

the root of the transverse mesocolon to the left of the spine. Bring the jejunum to the surface and clamp a portion of it, 9 inches from the angle, in a second pair of Doyen forceps. Surgeons are constantly lessening the length of the jejunal loop above the point of anastomosis. The distance of 9 inches has been almost classical, but it is now cut down by most operators to 4 or even 2 inches. A short proximal loop, so long as it does not drag the stomach upwards, is the best insurance against the "vicious circle."

Step 4.—Lay the two clamps side by side on the abdominal wall so that the portions of stomach and jejunum to be anastomosed are well outside the abdomen, embraced by the clamps. Protect the belly with pads, and make the anastomosis in exactly the same manner as in the case of an entero-enterostomy (page 276). The length of the continuous Lembert suture should be at least two inches. The openings in the stomach and gut should be $1\frac{3}{4}$ inches, and, corresponding to this opening, a strip of gastric mucosa $\frac{1}{2}$ inch wide ought to be removed. Moynihan lays great stress on this excision of the mucosa as a prophylactic measure against subsequent contraction.

Step 5.—The edges of the rent in the mesocolon may or may not be stitched to the stomach. Return the viscera to the abdomen and close the wound.

Maury's Method.—Maury's operation is essentially a modification of McGraw's, but is accomplished with materials always at hand.

Steps 1, 2, 3 are the same as in v. Hacker's operation, except that no clamps are used.

Step 4.—Lay the chosen segment of jejunum against the lowest portion of the stomach. Insert a row of Lembert sutures, 90 degrees distant from the mesentery, and so unite the intestine to the stomach. Leave the ends of this, the posterior line of Lembert sutures, long.

Step 5.—Thread a straight, round needle (darning-needle), 3 inches long, with very strong twine. Introduce the needle into

the stomach at the point A (Fig. 263). Be sure the mucosa is penetrated. The point A should be near the vessels of the greater curvature, and the distance between A and X (the mid-point of the line of Lembert sutures) should be less than the diameter of the gut. Bring the needle out from the stomach at the point B, ¼ inch from the beginning of the Lembert suture. Make

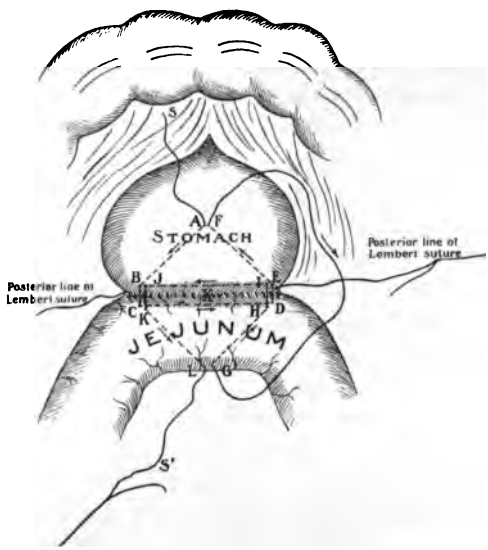


FIG. 263.—MAURY'S METHOD OF GASTRO-ENTEROSTOMY.

the needle traverse the intestine from C to D and the stomach from E to F. The points D and E must be ¼ inch from the end of the Lembert suture.

Make the same needle and thread traverse the gut from G to H, the stomach from I to J, and lastly the gut from K to L.

This apparently complicated but really simple series of stitches forms two equal triangles the apices of which (A F, L G) are equidistant from the middle of the base (X).

Step 6.—Tie the ends of the twine (S, S′) together very tightly. This is of great importance, as necrosis of the included tissues is essential.

Step 7.—Continue the line of Lembert sutures already in place completely around the site of the twine. The tying of the twine will have thrown the surface of the gut into a number of radiating folds, therefore to obliterate these while completing the Lembert sutures insert the stitches so far as possible at the bottom of these sulci.

Many surgeons, to avoid the possibility of the formation of a "vicious circle" (page 259), complete the gastro-enterostomy by forming an anastomosis between the afferent and efferent loops of jejunum at a point 6 inches lower down the gut (Fig. 265).

FIG. 264.

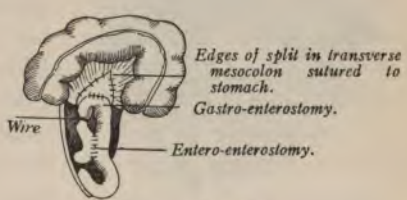


FIG. 265.

Fowler, to make assurance doubly sure, encircles the afferent loop, between the two points of anastomosis, with a silver wire thread to obliterate its lumen; the same object may be attained by a purse-string suture of silk around the gut at the same place. Instead of using the Fowler wire occlusion, some surgeons completely divide the afferent loop between the two points of anastomosis and close the open ends of the gut by purse-string sutures (Fig. 264). This method has all the advantages of Roux's operation, but does not interfere to the same extent with the mesentery.

In cases of duodenal ulcer requiring gastro-enterostomy Berg and Čačkovic have supplemented the anastomosis by encircling the pylorus with a purse-string suture, and thus are able to prevent gastric contents reaching the duodenum. It is certain that in the hands of most surgeons, the dangers of the vicious circle are less than those incident to the complicated methods devised for its avoidance.

Mikulicz-Czerny Operation.—Mikulicz and Czerny perform a gastro-jejunostomy based on two simple principles: "First, the origin of the jejunum lies above the greater curvature of the stomach. After opening the transverse mesocolon and fastening it to the posterior wall of the stomach, the upper three or four inches of the jejunum lie directly in contact with the gastric wall, hanging perpendicularly with its free border (opposite the mesentery) facing the stomach-wall. Second, by making a transverse incision in the jejunum three or four inches from its origin and an incision close to the greater curvature of the stomach, a suture anastomosis is made in which the stomach is drained at the lowest point without the possibility of kinking the intestine."

FIG. 266.—(*Monod and Vanverts.*)

Czerny was the first to carry out this operation, but used the Murphy button. Petersen notes that unless the anastomosis is exceedingly close to the origin of the jejunum obstruction may take place. Petersen is enthusiastic over the method. Experience in America has not been favorable to the Mikulicz-Czerny operation; a reverse vicious circle seems to have been established in too many cases, *i. e.*, material—*e. g.*, bile, etc.—seems to pass along the duodenum, enter the jejunum, and then pass into the stomach. In one case operated on by the writer there

was an unusual and annoying amount of vomiting for some weeks after the operation. Other surgeons have had worse experiences.

Roux's Operation; Operation en Y.—Steps 1, 2, 3, as in posterior gastro-enterostomy.

Step 4.—Having chosen the appropriate portion of jejunum, empty it of its contents, apply two clamps, and completely divide the gut between them. Anastomose with suture or button the open end of the lower segment of gut to the posterior wall of the stomach (Fig. 266). Anastomose the open end of the proximal or duodenal segment of the gut to the side of the lower segment of gut, a few inches below the site of the gastro-enterostomy.

The Vicious Circle.—When the afferent portion of gut is so placed that stomach contents pass into it instead of into the efferent loop, grave consequences are liable to ensue, and to the condition the name "vicious circle" has been given. Many precautions have been taken to avoid this accident, but only the more important and effectual will be mentioned. In Mayo's experience the main thing is to make the gastric opening at the lowest point on the anterior wall of the stomach. Kocher does the same, but adds a protective valve to the afferent segment (page 252). The accident seems to be very rare after posterior gastro-enterostomy. Roux's operation, "en Y," almost precludes its possibility, and the various methods of adding an entero-enterostomy to the gastro-enterostomy give safety in regard to the vicious circle, but of course add distinctly to the gravity of the operative procedure.

Peptic Ulcer.—Braun and Mikulicz have shown that the duodenum and upper segments of the jejunum are more resistant to the corrosive action of the gastric juices than are the lower segments of gut. In posterior gastro-enterostomy the portion of gut opened is 9 inches below the duodenojejunal fold, while in the anterior operation it is 16 to 20 inches below that point. Several cases of fatal peptic ulcer have been noted after the anterior operation—hence this constitutes an argument in favor

of the posterior. Mayo Robson has operated with success in this condition, excising the ulcerated gut and reëstablishing the anastomosis after Roux's method ("Annals of Surg.," Aug., 1904). The ulcers occur at the point of anastomosis or within 4 inches of it.

Choice of Method in which to Effect the Anastomosis.—1. *Suture.*—In the hands of experts undoubtedly the method by suture is the most satisfactory. Few surgeons, however, could equal Moynihan's record of a posterior gastro-enterostomy (sutures) completed in seventeen minutes. In cases where time is not the prime consideration, probably this method is the best, but in the exhausted and feeble the junior surgeon will find the Murphy button and the McGraw elastic ligature time-saving contrivances.

2. *Murphy's Button.*—(Method of use, see pages 279 and 286.) Many surgeons use this instrument in all their anastomoses. It is not quite so safe and efficient as the suture, except in respect to the saving of time. Mikulicz reserves the use of the button for cases of malignancy. Moynihan has given it up definitely as unnecessary and hazardous. Ochsner gives a useful warning against its employment in scar tissue. In the hands of the *average* surgeon the button holds its own as a time-saving and hence a life-saving instrument.

3. *McGraw's Elastic Ligature.*—(Method of use, page 282.) This ingenious method occupies a place midway between the suture method and the button. It is more rapid than the former and slower than the latter, but is safe. In the hands of McGraw, Willy Meyer, and others it has given great satisfaction. The principal disadvantage to it is that in emergency one will almost never have the proper rubber ligature at hand ready for use.

In order to give nourishment early after gastro-enterostomy and at the same time avoid irritating the stomach with food A. Hammesfahr ("Centralblatt f. Chir.," June 6, 1903) uses Rutkowsky's method of combining a gastro-enterostomy and a gastrostomy. A catheter is introduced through the gastric fis-

tula into the jejunum and kept in place until the stomach is in condition to take care of food. Feeding is carried on through the catheter. On removal of the catheter the fistula quickly closes.

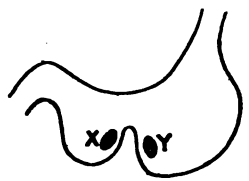


Fig. 267.

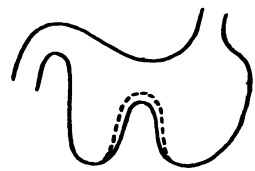


Fig. 268.

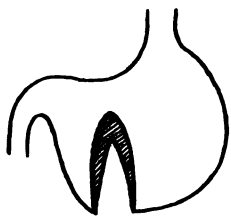


Fig. 269.

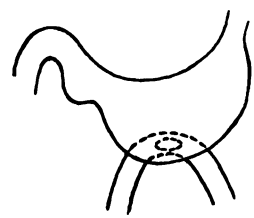


Fig. 270.

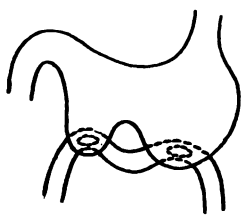


Fig. 271.

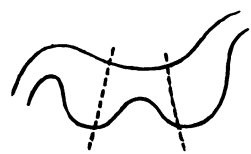


Fig. 272.

FIGS. 267–272.—(*Moynihan.*)

Operations for "Hour-glass" Stomach.—The figures (267–272*) sufficiently explain the methods of operating on hour-glass

* Figs. 267–272 are taken from Moynihan's work, but Figs. 268 and 269 have been modified.

contraction of the stomach. In Fig. 267 an anastomosis is made between the two gastric pouches, at the points X and Y. In Fig. 270 the cardiac pouch, being large and dependent, is united to the jejunum. In Figs. 268 and 269 an incision is made through the lowest part of the constriction, and when the edges of the cardiac side are united to those of the pyloric side, the normal shape of the stomach is more or less restored. The principle of this operation is identical with that of Mikulicz's pyloroplasty.

OPERATIONS UPON THE PYLORUS.

Pylorodiosis.—When pyloric stenosis is due to spasm or hypertrophy of the sphincter, this operation may be indicated, but as it has proved to be by no means safe, and recurrence of

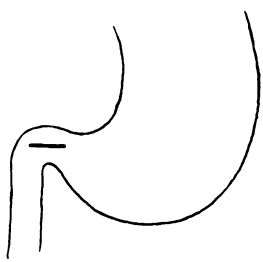


FIG. 273.

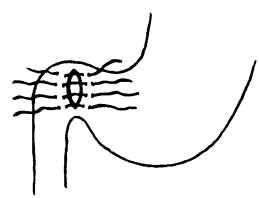


FIG. 274.

the trouble is frequent after its performance, and as other methods give more certain results, the operation is not much in favor.

Hahn's Method of Performing Pylorodiosis.—Expose the stomach by an incision to the right of the middle line. With the finger invaginate a portion of the anterior wall of the stomach and push it, along with the finger, through the pylorus. When the pylorus is sufficiently dilated, close the abdominal wound.

Loreta's Method.—Expose the pylorus. Incise the stomach near the pylorus. Through the stomach-wound pass the forefinger of each hand into the pylorus and forcibly dilate it. Instead of the fingers bougies may be used.

Pyloroplasty (Heineke-Mikulicz operation) is indicated in cases of spasmodic or cicatricial pyloric stenosis.

Step 1.—Expose the stomach near the pylorus by a vertical incision. Explore the *whole* stomach lest coexistent disease be overlooked. Separate adhesions which may exist around the pylorus. If possible, pull the pylorus out of the abdomen. Protect the peritoneal cavity with gauze pads. Clamp the stomach and duodenum with appropriate instruments (*e. g.*, Doyen's clamps).

Step 2.—Make a small opening into the stomach near the stenosis. Pass a finger or an instrument through the pylorus as a guide. It is generally advised to make a longitudinal incision through the *anterior* wall of the pylorus, completely dividing the stricture, and then to convert the longitudinal into a transverse wound and close it by sutures (Figs. 273, 274). But, as Mikulicz remarked, "that is not the way we do it." According to him, the longitudinal incision is made on the under surface of the stenosed pylorus (Fig. 275, A, B, C). Having made this inferior incision, unite the posterior edges of the wound first by a continuous or interrupted row of Lembert sutures, and then by a row of sutures embracing the whole thickness of the walls. Continue the latter row so as to close the anterior edges of the wound, and complete the union by inserting an anterior row of Lembert sutures. It is very evident that this method possesses all the good qualities of that usually described, and has the great advantage, in addition, that it lowers the level of the exit of the stomach. The operation is practically identical with Finney's operation, except that this

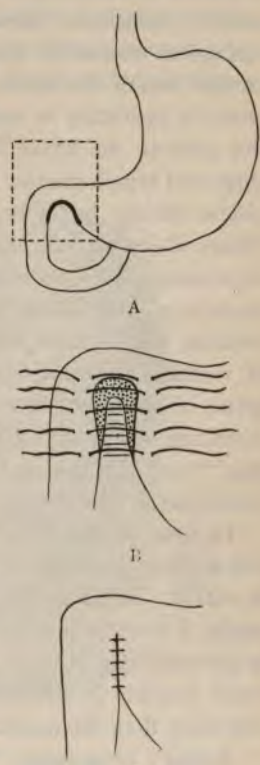


FIG. 275.

surgeon makes the opening larger. It would be well to insert the posterior row of Lembert sutures *before* incising the pylorus; this is done in Finney's operation.

Pylorectomy.—This operation is commonly supplemented by a partial gastrectomy. The indications for its performance are usually malignant disease, or pyloric ulcer and its sequelæ. Malignant disease of the pylorus usually spreads towards the cardiac end of the stomach, especially along the lesser curvature; hence in operating in malignancy it is wise to excise along with the pylorus the whole lesser curvature of the stomach and all suspected lymph-glands. "In cutting across the stomach the incisions should be 1½ to 2 inches wide of the disease at least" (Mayo Robson). As malignant disease does not, as a rule, infiltrate towards the duodenum, the division of the duodenum may be made at a point about ¾ to 1 inch away from the disease. "In excising glands from the great omentum there is great danger of wounding the middle colic artery and thereby causing gangrene of the transverse colon. The glands along the greater curvature are most numerous near the pylorus." (Mayo Robson, "Surg. Treatment Diseases of the Stomach.") This danger is avoided in the method described on page 270.

In view of the facts stated in the preceding paragraphs, it follows that the original operations of pylorectomy were defective in extent. When a sufficiency of the viscus is removed, it will rarely, if ever, be possible to unite the open end of the duodenum to the open end of the stomach (partially closed by sutures), and when possible it will be much more difficult, time-consuming, and risky than the methods to be described.

Kocher's Operation.—The preparation for pylorectomy is the same as for gastrotomy. The stomach is exposed by a vertical incision in or near the median line, supplemented if necessary by a transverse cut through the right rectus.

Ligate the gastrohepatic omentum from the pylorus to the coronary artery, and divide it as close to the liver as possible (Fig. 276). This removes as much suspected lymphatic tissue as possible. Expose and tie the coronary artery near the œso-

phageal end of the lesser curvature. With the fingers tear through the great omentum close to the stomach, and through this rent pass one blade of a clamp (Doyen's, Kocher's) behind the stomach, the other blade being in front. Secure the clamp in position a little to the left of the line chosen for division of the stomach. Place a second clamp on the stomach parallel to and one inch to the right of the first. If the blades of the clamps are not long enough to grasp the whole distance from the greater to the lesser

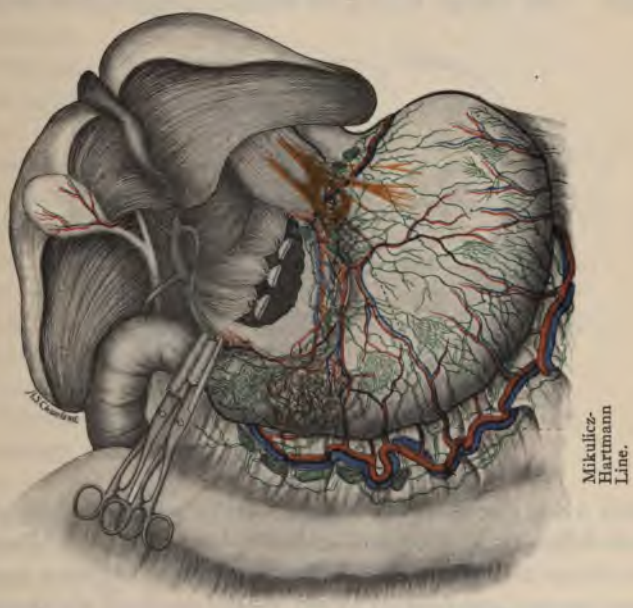


FIG. 276.—(*Mayo.*)

curvatures, they may be supplemented by others applied over the lesser curvature. Divide the stomach between the clamps, either with the cautery or a knife; if the latter is used, with a strong antiseptic cleanse the line of section. Turn the pyloric end of the stomach (closed by clamps) to the right, thus exposing its posterior surface and the duodenum. As the stomach is being turned over, doubly ligate in sections the great omen-

tum and divide it. The gastroduodenal artery is exposed and ligated (Fig. 277). These steps isolate the portion of the duodenum to be removed. Apply two clamps to the duodenum and divide between them. Cleanse the cut surface of the duodenum and temporarily cover it with gauze after noting whether or not it can be brought into contact with the posterior surface of the remaining portion of the stomach.

The excised portions of the stomach and pylorus are thrown aside. The clamps closing the stomach being still in position,

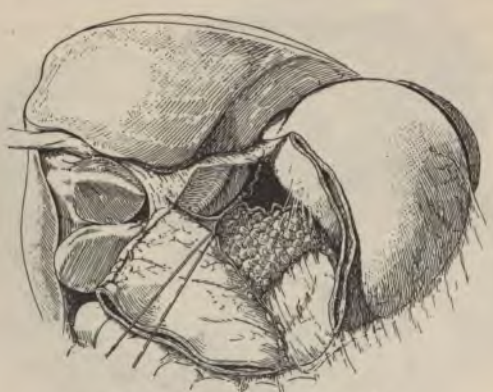


FIG. 277.—(*Monod and Vanverts.*)

apply a continuous (better a shoemaker's) suture immediately to their left—*i. e.*, to their proximal side—and tie tightly. Remove the clamps and excise any exuberant mucosa. Apply a continuous through-and-through suture to the whole of the stomach-wound. Bury this line of suture by a line of continuous Lembert sutures, reinforced where necessary by a few isolated Lembert stitches.* Bring the duodenum without tension into apposition with the posterior surface of the stomach. With a continuous Lembert suture unite the posterior wall of the duode-

* The clamps on the stomach should be applied with much force. The tissues crushed by them are not expected to unite; they are invaginated by sutures inserted in sound structures.

num to the stomach. Incise the stomach (Fig. 278). With a continuous through-and-through suture unite the open end of the duodenum (clamps having been removed and the assistant's fingers substituted for them) to the gastric opening. This line of suture is hemostatic and temporarily prevents escape of visceral contents. Continue the line of Lembert sutures already in position around the front of the gut and stomach, thus completing the safe implantation of the open end of duodenum into the posterior wall of the stomach at as low a point as possible.

The operation as above described is unnecessarily complicated; the union of the open *end* of the gut to the stomach-wall is more difficult, if the suture method is employed, than is lateral anastomosis; above all, the results have not been nearly so good as those obtained from the next operation to be described, and which, in the author's judgment, is the operation of choice.

FIG. 278.—(*Monod and Vanverts.*)

Pylorectomy or Partial Gastrectomy.—The following operation may be dubbed "the Rochester method"; its basis is the second Billroth operation. It has been elaborated by the Mayos, and although almost every feature of it has been devised by others, yet these surgeons have so systematized the steps and brought it to such a degree of safety that the description here given is an exact account of their method. Of 15 gastrectomies performed in the Rochester manner by the Mayos, only *one* died; in their hands, 5 died out of 20 operated on by other methods.

Step 1.—Make a longitudinal incision between the ensiform cartilage and umbilicus in or near the middle line. Explore the stomach and the biliary passages (as routine).

Step 2.—Ligate the gastric or coronary artery close to the stomach (Fig. 276). Ligate the lesser omentum close to the liver, in three or four segments and divide it. Ligate the pyloric branch of the hepatic artery.

Step 3.—Apply two clamps on the duodenum distal to the disease and about ¾ to 1 inch apart. The clamps should be

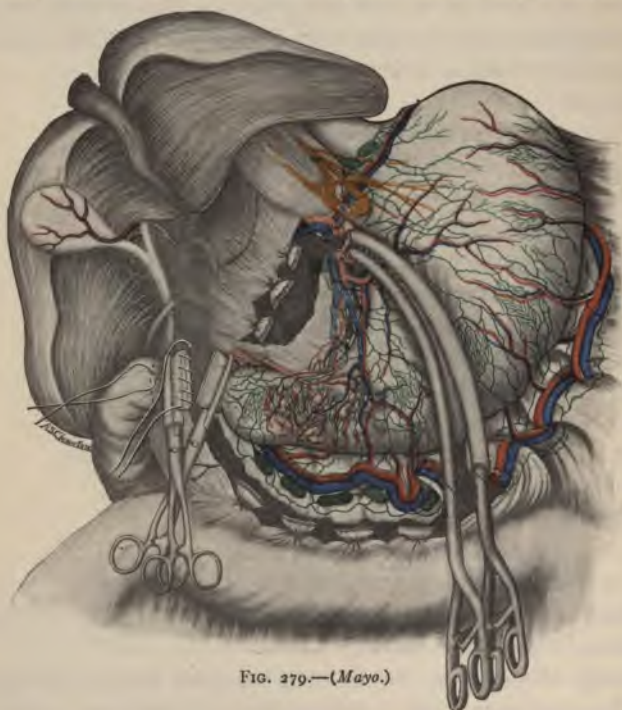


FIG. 279.—(*Mayo.*)

heavy and applied tightly. With the cautery, divide the duodenum between the clamps. Leave a stump about ¼ inch long protruding from the distal clamp.

Step 4.—Introduce a continuous catgut stitch through the end of the duodenal stump protruding from the forceps (Fig. 279). Tie the ends of this suture firmly together. As the first

knot is being tied remove the clamp. The result is that the end of the duodenum is closed and bunched into a small compass. Bury the sutured end of the duodenum by means of a purse-string suture (Fig. 280). This completes the care of the duodenum.

Step 5.—Pass the left hand from above downwards behind the pylorus and stomach and lift forwards the great omentum.

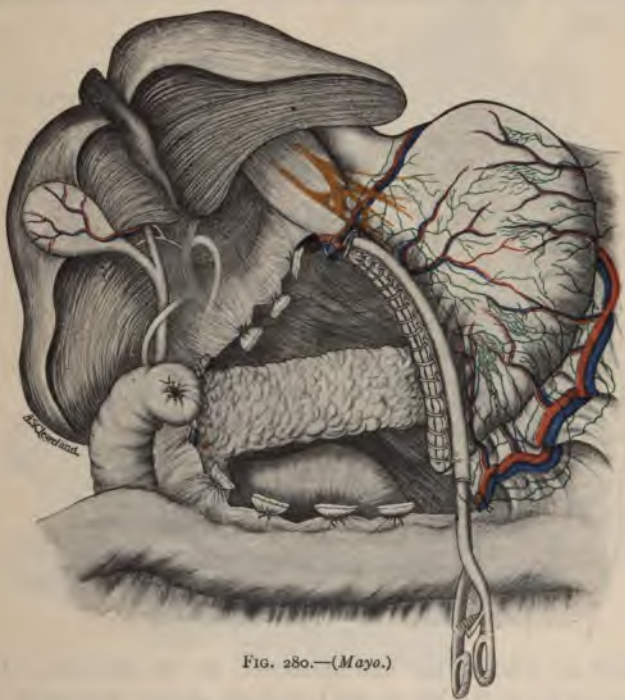


FIG. 280.—(*Mayo.*)

Ligate the right gastro-epiploic artery very close to the stomach. Ligate the left gastro-epiploic artery. Ligate, in three or four segments, the great omentum. Interlocking ligatures are not required. The left gastro-epiploic artery must be tied well to the left of the disease, and in any case of cancer well to the left of the last of the glands in the great omentum which are

related to the diseased area. Figs. 279 and 280 show the arrangement of the lymphatics of the stomach. The great danger to be avoided in ligating the vessels in this step is that of including in the ligature the midcolic artery and thus causing gangrene of the transverse colon. The passage of the hand behind the stomach and the consequent elevation of the great omentum entirely avert this danger. Divide the great omentum, leaving attached to the stomach that portion containing lymph-glands (Fig. 279).

FIG. 281.—(*Cuneo.*)

Step 6.—Choose the line of section on the stomach. This line must be to the left of the lymphatic glands, into which the diseased area drains (Figs. 281 and 282). Immediately to the left of the line of section apply a Kocher clamp, the blades of which are protected with rubber tubing. To the right of the line of section apply crushing clamps of any convenient variety. These latter clamps merely prevent escape of contents from the segment of stomach about to be removed. Divide the stomach

along the line of section with the cautery, leaving a stump of about ¼ inch protruding from the Kocher clamp. As the section is being made seize the protruding stump in three or four places with small volsella or hemostats to prevent the stump slipping through the Kocher clamp. This precaution is important, as

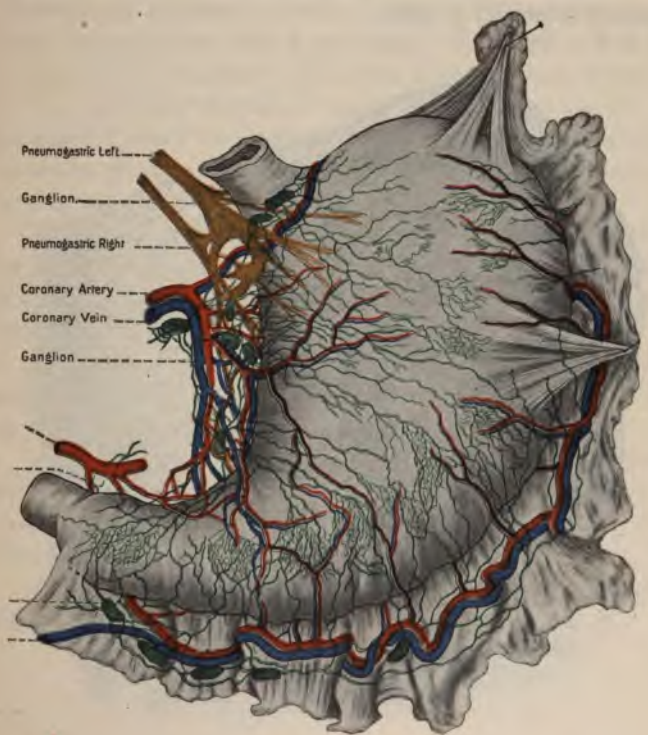


FIG. 282.—(*Mayo.*)

such slipping means—(*a*) that stomach contents may escape and soil the wound; (*b*) that air enters the stomach, and experience has shown that the suction of air into the stomach during a gastrectomy is very dangerous, and that for some obscure reason pulmonary troubles are liable to develop.

Step 7.—To the stomach stump insert a row of lock stitches (Fig. 280). These must be introduced through all the coats of the stomach and pulled tight. A second row may be introduced as an additional safeguard. Remove the Kocher clamp. Bury the closed stomach stump by a row of continuous Lembert or Cushing sutures, reinforced, if necessary, by a few points of Lembert sutures (Fig. 283).

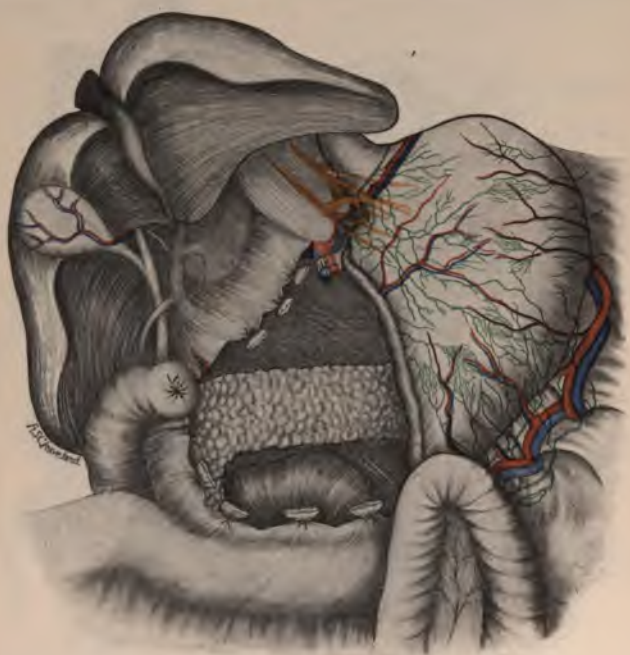


FIG. 283.—(*Mayo.*)

Step 8.—Perform a gastro-enterostomy, either anterior or posterior, by uniting an appropriate portion of jejunum to the lowest part of the remainder of the stomach, with button or suture (Fig. 283).

Step 9.—If many adhesions have been separated, especially

on the posterior wall of the stomach, introduce either a cigarette drain or a split rubber tube containing a few strands of gauze. The drain is rarely required. Close the abdominal wound.

After-treatment.—The special rules for the after-treatment of stomach operations are, shortly, as follows:

(*a*) If the patient is much dehydrated, give intravenous or subcutaneous infusions of saline solutions. These may be repeated during a few days if necessary. If not dehydrated and if stimulation is necessary, administer subcutaneously strychnine or a 20 per cent. solution of camphor in sterile olive oil. As the patient leaves the operating table 8 ounces of warm coffee should be given per rectum. Morphine in an efficient dose may be administered if required.

(*b*) As soon as the effects of the anæsthetic wear off (within a few hours) raise the patient into a sitting or rather semi-sitting posture. This tends to obviate pulmonary disturbances and is important.

(*c*) Twelve hours after operation small doses of hot water may be given by the mouth, and next day, if there is no nausea, an ounce of hot water may be given hourly.

(*d*) Nourishment must be by rectal feeding for from four to six days after operation, when fluid food may be given by the mouth. After thirty-six hours experiments with small quantities of predigested liquid food may be instituted.

(*e*) If a drain has been used, it may be removed about the sixth day.

CHAPTER III.

OPERATIONS ON THE INTESTINES.

THE DUODENUM.

Apart from operations which are essentially directed against the biliary passages, or from the operation of gastro-duodenostomy, the only lesion commonly calling for interference with the duodenum is ulceration. Duodenal ulceration is much more common than is usually supposed. The operative treatment depends on the presence or absence of perforation.

Perforation of the Duodenum.—The ulcer is almost invariably situated in the first 2½ inches of the gut, and is, therefore, accessible.

Step 1.—Open the abdomen by the right rectus incision. Guided by evidences of inflammation and by anatomical knowledge, expose the disease.

Step 2.—Cleanse the affected area. Protect the rest of the belly with gauze. If possible, close the perforations by Lembert sutures. If the closure seems insecure, reinforce it by an omental graft. In one case H. S. Clogg ("Brit. Med. Jour.," Jan. 2, 1905), unable to close the perforation by sutures, brought up the free edge of the omentum and stitched it around the perforation with excellent effect.

Step 3.—Provide for drainage through the primary incision; through a special opening made in the right loin just below the last rib, or when there is much peritonitis, provide pelvic drainage through an anterior wound and keep the patient in the Fowler position.

When the patient's general condition is good, it might be wise to follow Step 3 by performing a gastro-enterostomy so as to give rest to the duodenum and permit healing of the ulcer.

Ulceration without Perforation.—The treatment of ulceration and its sequel, stenosis, is gastro-enterostomy.

Enterotomy and Closure of Intestinal Perforations.—Enterotomy is the operation performed for the extraction of foreign bodies or for the evacuation of intestinal contents in certain cases of obstruction where enterostomy is not indicated. As the closure of the gut after incision is similar to the procedure required in perforation, the two subjects may be treated together.

Step 1.—Expose the intestine by an incision in or near the median line. Exceptionally some other incision is preferable.

Step 2.—Find and pull out of the belly the loop of gut to be attacked. (If the case is one of perforation, empty the loop by stripping it with the fingers and apply clamps or their equivalent.) Protect the belly cavity with pads.

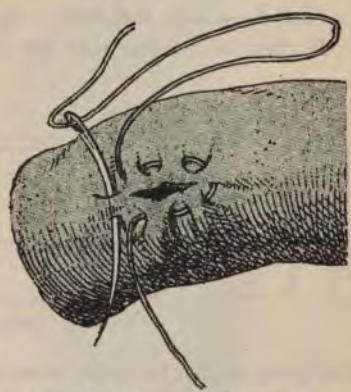


FIG. 284.—(*Monod and Vanverts.*)

Step 3.—Make a longitudinal incision through the intestinal wall on the side opposite to the mesenteric attachment. Extract the foreign body. Undoubtedly a longitudinal incision when closed narrows the gut lumen more than does a transverse, but the amount and danger of this narrowing have been much exaggerated and the longitudinal cut is the more convenient and practical.

Step 4.—Closure of the intestinal wound.

(A) If the opening is very small, one or two points of Lembert sutures will suffice, or a purse-string suture may be better (Fig. 284).

(B) If the opening, while longer, is linear, insert a row of continuous through-and-through sutures for hemostasis and occlusion, and cover these by a line of Lembert sutures, either

continuous or interrupted. Some surgeons do not use the deep row of sutures, but it is both a convenient and a safe procedure.

(C) If the opening is large, or so contused or diseased that sutures close to it will not hold, direct closure, whether transverse or longitudinal, leads to serious obstruction (Fig. 285). The effects of the resulting stenosis may be discounted by making an anastomosis between the loop of gut leading to and that going from the stenosis, or the injured segment of intestine may be excised.

Step 5.—Cleanse the exposed gut. Review the line of suture reinforcing it, where necessary, by points of Lembert sutures. Remove the protective pads. Replace the intestines in the belly.

Step 6.—Close the belly. Apply dressings.

If there is any fear that the intestinal sutures will fail to do

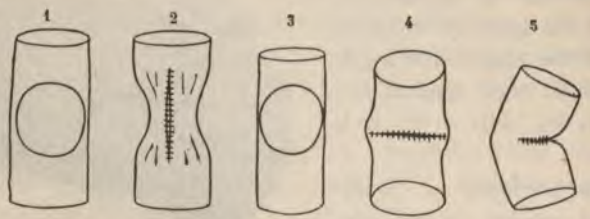


FIG. 285.—(*Monod and Vanverts.*)

their duty, many, probably most, surgeons apply a wick of gauze or cigarette drain to the wounded gut, bringing the free end of the drain out through the parietal wound. To the writer it appears that such a precaution is liable to lead to the very state of affairs it is meant to prevent; that the foreign body or drain close to the line of suture may possibly interfere with the process of repair.

Lateral Anastomosis by Means of Suture.—The following operation is in all essentials that described by Abbé:

Step 1.—Bring outside the abdominal cavity, which is protected by gauze pads, the loops of gut to be united. Place the loops together in such a manner that about five inches lie in contact. Squeeze the contents out of the loops and apply suitable clamps to keep them empty.

Step 2.—Unite the two loops of gut for about four inches by

a row of continuous suture (continuous Lembert), parallel to and not far from the mesenteric border. The stitches involve the serous, muscular, and fibrous or submucous tunics. Fasten the suture with a knot (Fig. 286).

Step 3.—At a safe distance from the line of suture A, B, make the opening X, Y, in one of the loops. The opening must be about one inch shorter than the line of suture A, B. A portion of intestinal wall about one-half inch in width may be excised along the line of the opening X, Y. This, however, is optional. Seize any bleeding points with forceps. Repeat Step 3 on the other loop of gut.

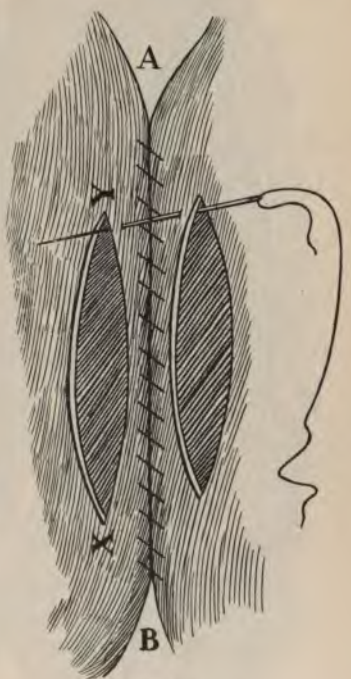


FIG. 286.

Step 4.—With a continuous catgut suture unite the corresponding edges of the openings in the two loops of gut (Fig. 287). This continuous suture involves all the coats of the intestine and shuts off the intestinal cavity from the line of Lembert sutures; at the same time it prevents loss of blood. The suture may be applied in the Connell fashion. (See page 288.)

Step 5.—Continue the line of suture A, B (posterior row of Lembert suture) completely around the site of the anastomosis (Fig. 287, L, L, L), thus entirely burying from view the occlusion or hemostatic sutures introduced in Step 4. Fig. 288 shows the last of these sutures being introduced in the interrupted fashion. The continuous suture is as good as, or really better than, the interrupted.

Step 6.—Review the line of suture and if necessary reinforce it by a few extra stitches. Fig. 289 shows a sectional view of the anastomosis.

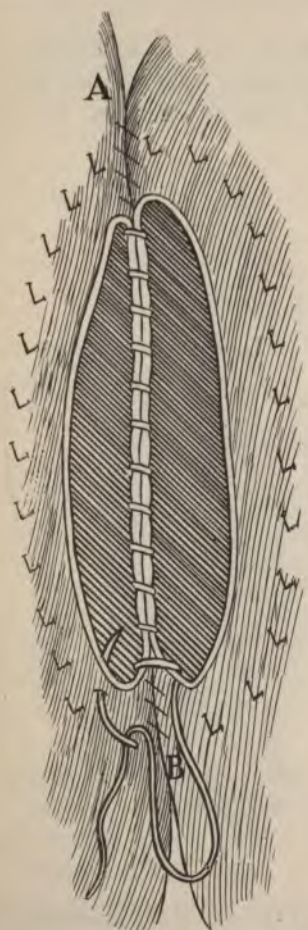


FIG. 287.

Step 7.—Remove the intestinal clamps. Clean the wound. Remove gauze pads. Return the intestines. Close the abdominal wound.

Dr. Charles T. Parkes recommended a smaller opening in the gut than that described above. After making a longitudinal incision through the intestinal wall at a point *opposite* the mesenteric attachment, he made a short transverse incision at either end of it and so formed two flaps of gut-wall which he turned inwards, fastening them in this position by a few sutures. The turning-in of the flaps prevented contraction of the anastomotic openings. After making the openings in the opposing loops of gut, Parkes completed the union by a single row of continuous Lembert sutures, each stitch involving one-third inch of intestinal wall, the stitches being one-eighth of an inch apart. "It makes no difference whatever what kind of suture is used, so that the principle of positively securing the application of two broad surfaces of peritoneum in contact with each other is certainly carried out." (Parkes.)

Lateral Anastomosis by Means of the Murphy Button.—*Step* 1.—Having opened the belly, pull the two loops of gut which it is desired to unite out from the abdominal cavity and protect the latter with gauze pads. Empty the segments of intestine and keep them empty by means of clamps.

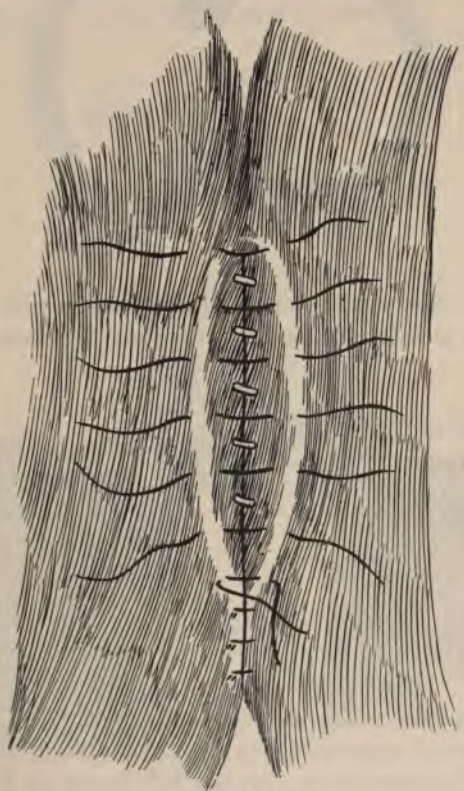


FIG. 288.

Step 2.—Introduce a purse-string suture of fairly stout silk or catgut into the gut opposite its mesenteric attachment. The suture pierces all the coats of the gut. Make a longitudinal opening into the gut, large enough to permit the introduction of a

Murphy button of appropriate size. This cut is in the area surrounded by the purse-string suture (Fig. 290).

FIG. 289.

Step 3.—Seize one half of the Murphy button with hemostatic forceps and introduce its head into the gut. Weir has found that

Fig. 290.

Fig. 291.

FIGS. 290 AND 291.—(*Monod and Vanverts.*)

the forceps may so injure the button as to render it unsafe. Dawbarn plugs the two segments of the button with corks, thus providing handles and at the same time preventing escape of intestinal

contents. Cordier has devised ingenious metal handles to plug the button and take the place of the corks.

Pull the purse-string tight and tie it in such a manner that the opening in the gut is snugly fastened around the neck of the button (Fig. 291). With scissors or knife remove any excess of tissue distal to the suture which might interfere with the proper approximation of the two halves of the button.

Fig. 292.

Fig. 293.

FIGS. 292 AND 293.—(*Monod and Vanverts.*)

Repeat Steps 2 and 3 on the other loop of gut.

Step 4.—Remove the hemostatic forceps or corks from the two halves of the button. Insert the neck of the male half of the button into that of the female half and push them together firmly (Figs. 292 and 293). A few points of Lembert suture may be used to reinforce the union.

In Step 2 the incision may be made into the gut before the purse-string suture is introduced. A good method of applying the stitch is shown in Fig. 294.

Step 5.—Close the wound "*a*" by appropriate sutures. Repair the mesentery (Fig. 303).

Fig. 304.

Fig. 305.

Fig. 306.

FIGS. 304, 305, 306.—(*Da Costa.*)

End-to-end Union by Means of the Murphy Button.—This operation is practically the same as that described for

lateral anastomosis. The only point to be specially noticed is the method of closing the mesenteric space or insertion with the purse-string suture. Figs. 294, 304, 305, 306, explain themselves.

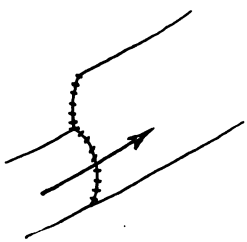


FIG. 307.

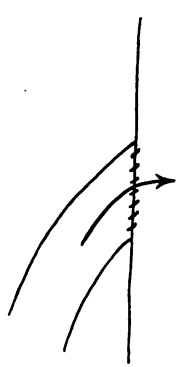


FIG. 308.

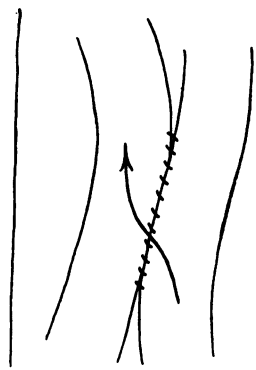


FIG. 309.

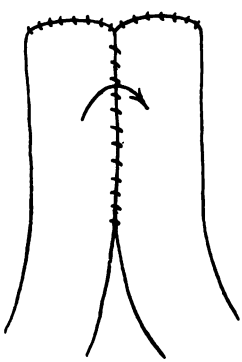


FIG. 310.

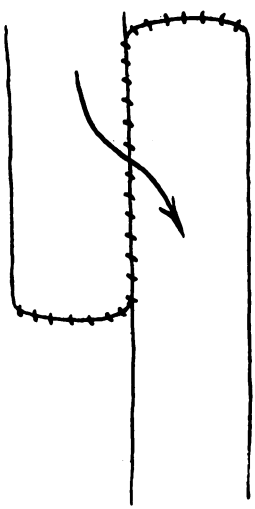


FIG. 311.

An endless number of contrivances—decalcified bone plates and bobbins, rawhide plates, catgut rings, segmented rubber

rings, vegetable plates, etc.—have been invented to simplify intestinal anastomosis, but most have been discarded as cumbersome and unnecessary. The same may be said of numerous devices to support or distend the lumen of the gut while stitches are being inserted.

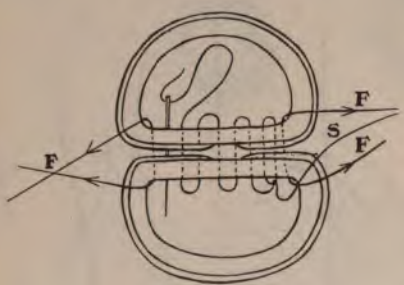


FIG. 312.

Of these, Harrington's segmented metal ring is probably by far the best. (See "Trans. Am. Surg. Assoc.," vol. xxii.)

The operation of lateral implantation, *i.e.*, where the end of one segment of gut is anastomosed to the side of another, is a combination of end-to-end and of lateral anastomoses, and as such requires no special description. Figs. 307 to 311 show a number of varieties of intestinal anastomosis and implantation.

Connell's method of enterorrhaphy is similar to Maunsell's in that the sutures penetrate the whole thickness of the gut-wall, and differs from it in the absence of the second incision into the gut.

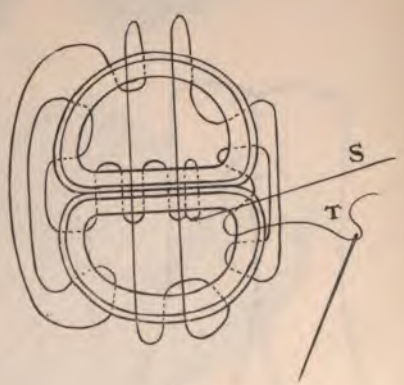


FIG. 313.

Step 1.—Place the ends of the gut in apposition, with the mesenteric attachment of one side corresponding to that of the other. Introduce two or more fixation sutures, F (Fig. 312), to insure accuracy and uniformity in stitching. Instead of

fixation sutures, miniature volsella may be employed. Introduce the continuous suture (S) as shown in Fig. 312. In this manner fully two-thirds or even three-fourths of the circumference of the gut may be united. The remaining third or fourth of the wound is not so simply united, but if Fig. 313 is carefully studied, the method will be clearly understood. When the two portions of gut are united and the suture pulled sufficiently tight, the two ends of the suture T, S, emerge at the same point (Fig. 314, x).

Step 2.—Introduce through the line of suture at the point Y, Fig. 314, a threaded needle. Make the eye-end of the needle

FIG. 314.

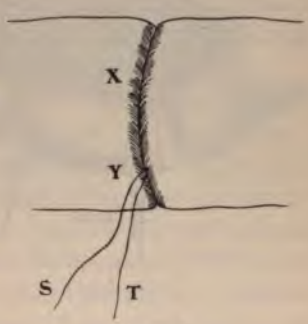


FIG. 315.

emerge alongside the sutures T and S, at the point x. Pass the ends of T and S through the loop of the thread in the needle and with the needle pull them out through the point Y.

Step 3.—Slight traction on T and S will bring the mucous surface of the gut at the point x into contact with the mucous surface at the point Y (Fig. 315). If now the sutures T and S are tied tightly together and the knot allowed to slip through the line of union at the point Y, this will sufficiently fasten the sutures. The student is strongly advised to familiarize himself thoroughly with this method before attempting it on the living. An old coat makes a good model on which to practise this opera-

tion. Imagine the wrist ends of the sleeves to be open ends of gut and unite them. A few minutes of such practice with a coarse needle and thread makes easy the comprehension of this rather puzzling stitch.

Resection of a Portion of Small Intestine.—The indications for this operation are localized malignant or benign tumors; localized tuberculous lesions; gangrene; traumata extensive enough to contraindicate local suturing, etc.

The Operation.—Step 1.—Open the belly in the middle line.

Step 2.—Pull the affected loop of gut outside the belly and protect the peritoneal cavity with gauze pads.

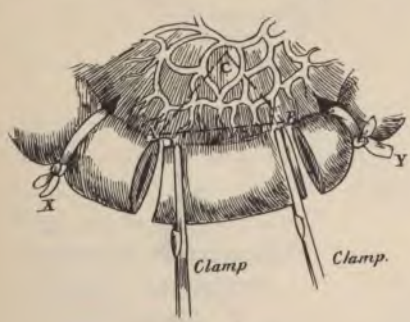


Fig. 316.

Step 3.—Empty the contents from the intestinal loop by "stripping" with the fingers. Apply clamps.

Step 4.—Note the blood-supply as it passes through the mesentery. Ligate the vessels supplying the portion of gut to be removed.

Step 5.—Divide the intestine on each side of the disease at a point where it is well supplied with blood (Fig. 316). Section of the gut should be made obliquely, more of the free border being removed than of the mesenteric. This is done—(*a*) because when obliquely divided the open ends of gut have a greater circumference than when cut transversely, and hence allow for the loss of diameter occasioned by suturing; (*b*) because the gut-wall on the non-attached border is more liable to be well nourished. If desirable, excise a V-shaped portion of mesentery corresponding to the segment of gut removed.

Step 6.—Either unite the ends of the gut by an end-to-end anastomosis, or close them by means of suture, preferably purse-

string, and provide for intestinal continuity by a lateral anastomosis.

Step 7.—If a V-shaped portion of mesentery has been removed, unite its edges by suture. If this has not been done, fold any redundancy upon itself and secure by a few stitches.

Step 8.—Review the wound. Cleanse. Remove gauze pads. Return the gut into the belly. Close the abdomen.

Cæcectomy is indicated in cases of malignant or tuberculous disease, as well as in some cases of intussusception.

Step 1.—Open abdomen in right semilunar line; expose and examine the diseased organs.

Step 2.—Incise the posterior parietal peritoneum at the outer side of the cæcum and ascending colon. Free the cæcum from its bed by finger dissection. Ligate and divide the branches of the ileocolic artery to the necessary extent. Completely mobilize the diseased segment of gut.

Step 3.—Treat the mobilized gut as in Paul's colectomy (and this is the safer plan), or proceed as follows:

With two crushing forceps applied about one inch apart strongly clamp the ileum at a point 6 to 8 inches above the cæcum. Divide the gut between the forceps. Cleanse the cut surfaces. Treatment of the proximal segment of the ileum: (*a*) With a continuous suture tightly close the open end of the gut (*i. e.*, distal to the clamp); (*b*) surround the gut about 1½ inches proximal to the clamp with a purse-string suture; (*c*) remove the clamp; invaginate the sutured end of the gut and tighten the purse-string sutures. In the same manner with crushing forceps doubly clamp and divide the ascending colon distal to the disease. Remove the diseased segment of gut. Treat the distal segment of colon in the same manner as the ileum.

Make a lateral anastomosis between the ileum and the colon or sigmoid.

Colectomy (Sigmoidectomy).—A diseased portion of the colon may be removed in the same manner as described under the title "Enterectomy." If it is possible to bring together the divided ends of the gut without too great tension, they may

be united by means of suture or Murphy's button. As a rule, such end-to-end union is impossible, and one must content one's self with closing the ends of the gut with a double row of sutures and establishing an anastomosis between a suitable loop of small intestine and the colon distal to the excision. If the cæcum has been excised, it may be convenient to implant the open end of the divided small intestine into the colon.

Paul's Colectomy.—Step 1.*—Make a free incision through the parietes over the part of the colon to be removed.

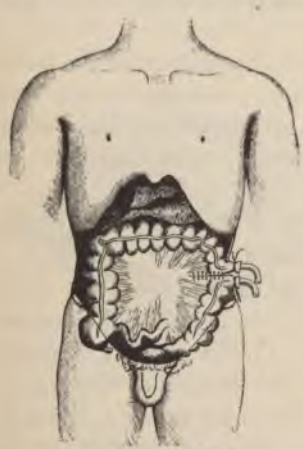


FIG. 317.—(*Maylard.*)

Step 2.—Ligate and divide the mesocolon sufficiently to free the gut well above and below the disease.

Step 3.—Pull the freed loop of gut through the abdominal wound. Sew together the healthy segments of gut which pass through the abdominal wound (Fig. 317). Unite the cut surfaces of mesocolon.

Step 4.—Make an incision into the prolapsed gut above and below the disease. Into each intestinal opening pass a glass tube and ligate it there.

Step 5.—Cut away the diseased portion of gut.

Step 6.—Partially close the abdominal wound. Apply dressings.

The result of this operation is, of course, a fæcal fistula, which may be closed later.

Enterectomy in two stages has a mortality of about 10 per cent., while that in one stage (for malignant disease) has 30 to 40 per cent. (v. Mikulicz). In about 30 per cent. there is no recurrence of the malignant disease after four years. The operation in two

* A. E. Barker strongly recommends an oblique incision in the loin.

stages may be employed in excision of the lower end of the ileum with or without excision of the cæcum.

Exclusion or Segregation of Intestine.—In some cases where, from extensive adhesions or from other causes, it seems impossible or improper to excise a certain segment of gut, good results may be obtained by protecting it from the irritations incident to the performance of its physiological functions. In this way fæcal fistulæ may be induced to close and some neoplasms may develop less rapidly. The operation which is used for this purpose may be named "*exclusion of the intestine.*" Tuberculous lesion of the intestine, unless fairly easy of excision, may well be treated by exclusion.

Arbuthnot Lane ("Brit. Med. Jour.," Apl. 1, 1905) highly recommends intestinal exclusion in cases of intractable constipation due to ptosis of the colon and chronic adhesive pericolitis. He divides the ileum about 8 inches above the cæcum, closes the distal end, and connects the proximal either with the sigmoid or the rectum. Contrary to preconceived notions, this operation is *not* followed by diarrhœa. In the following description it is assumed that the cæcum and adjacent segment of ileum are diseased and require to be segregated.

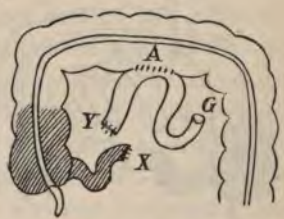


FIG. 318.

(A) *Unilateral Exclusion.—Step* 1.—Open the abdomen in a suitable position. Examine the diseased structures.

Step 2.—Find, empty, and doubly clamp the afferent segment of gut, *i. e.*, the portion of healthy gut which passes into the diseased segment. Divide the gut between the clamps. Close each end of the gut by arow of through-and-through sutures covered by a row of continuous Lembert sutures. If desired, the purse-string suture may be employed (Fig. 318, X, Y).

Step 3.—Make an anastomosis between the afferent loop of gut and the colon in a suitable place (Fig. 318, A).

Step 4.—Close the abdomen.

The effect of unilateral exclusion is that while the contents of the excluded segment drain into the colon, no material from the ileum passes into it—in fact, a short circuit is established.

(B) *Bilateral Exclusion.*—This method is proper only when a fistula leads from the skin into the segment to be excluded. The only difference between the bilateral and the unilateral operation consists in the division and suture of the colon distal to the disease and proximal to the anastomosis (Fig. 319).

(C) *Bilateral exclusion with drainage of the excluded segment.* Here no fistula leads into the diseased segment. The operation is identical with that of bilateral exclusion up to the

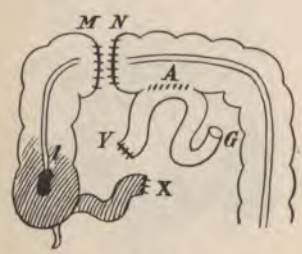


FIG. 319.

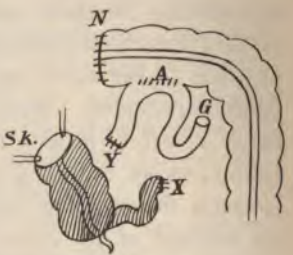


FIG. 320.

point where the colon is divided. Now, instead of closing both ends of the colon at the point of section, only the distal segment is closed (Fig. 320, N), while the open end of the diseased segment is united to the skin and permits drainage (Sk.).

Vautrin thinks and has proved that drainage from one end of the excluded segment of gut is only sufficient if the disease is of comparatively limited extent. Where the disease is extensive and the gut to be drained is more or less soiled, then both ends of the segregated segment should be united to the skin at convenient points; if necessary, special openings being made through the belly-wall. This permits of thorough drainage and lavage, whereby the diseased gut lumen may be kept clean and ulcerations may receive local treatment.

The operation of "exclusion" has a distinct place in surgery, and in America, at least, does not seem to have received sufficient recognition.

INTESTINAL OBSTRUCTION.

Whichever form of obstruction is present and demands operation, there are certain points common to the treatment of all of them, and which will be considered here.

As a matter of routine, the rectum must be explored; the omission to do this has too often led the surgeon to operate unnecessarily or to miss the aid of valuable information when operating. There is often not much time in which to prepare the patient. Enemata will almost certainly have been used before the question of operating has been decided, and hence the lower gut is empty. It is wise to clean out the stomach with the stomach-tube. The patient's resisting power should be stimulated by a hypodermic injection of strychnine and nitroglycerine. When there are great nervousness and depression, a small dose of morphine has a quieting and steadying effect which outweighs any ill which it may do. Usually the abdomen is opened in the middle line below the umbilicus. Through this opening any obstruction may be reached and treated.

How to Find the Point of Obstruction.—Theoretically one might proceed, as is usually advised, in the following methodical manner: Pass the fingers or hand into the right iliac region and palpate the cæcum. If the cæcum is distended, pass the hand along the colon, as the obstruction must be lower down. If the cæcum is not distended, the obstruction must be in the small intestine. Find a segment of gut which is not distended. Trace the mesentery of the loop of gut under examination to its origin from the spine and find which is its upper surface. Remember that the right layer of the mesentery is also its upper layer. Having found the upper or right surface of the mesentery, that portion of gut which goes to the left is the upper segment, and if followed will assuredly lead to the point of obstruction. Trace

the gut up to the point of obstruction, but do *not* let the intestines come out of the belly cavity.

But the belly-walls are generally tense, the intestines are ballooned with gas, the transverse colon is pushed up under the diaphragm, and to carry out the methodical examination described would be very hazardous even if possible. Greig Smith gives excellent advice as to finding the obstruction. He notes that wherever the obstruction is located it is probable that the most dilated coils will rise to the surface; and, the greater amount of bowel being within three inches of the umbilicus, it is probable that the most dilated coils will be within sight. Very gently move the coils from side to side and up and down, and fix on the most dilated coil, which will be at the same time the most congested. Follow this coil in the direction of increasing distension and congestion. "It will certainly lead to the stricture. The whole manipulation may be carried out with two fingers." If this method fail, Greig Smith recommends to let the most distended coil escape from the belly, protected by a large pad. One end of the coil escapes less readily than the other and appears more congested; this end of the coil will lead to the obstruction.

When the intestines are very much distended with gas, there are certain dangers to be feared and combatted during the operation:

1. During the necessary manipulations the pressure of the fingers or hand may cause rupture of the gut.

2. If rupture is avoided and the direct cause of obstruction relieved, the ballooning of the gut may cause kinking or valve formation of individual loops and so prevent emptying of the bowel.

3. Prolonged overdistention so paralyzes or weakens the intestinal muscles that they are unable to contract.

4. The operation being completed, it may be impossible to close the abdominal wound over the dilated intestines.

Greig Smith holds that "no operation for intestinal obstruction is properly completed if the patient leaves the operating table with a greatly distended abdomen."

Dahlgren ("Zentralblatt f. Chir.," Apl. 15, 1905), after incising intestines, "milks" it throughout its whole length, using gloved hands or a special instrument consisting of two cylinders like bobbins held together by a spring. This he find specially useful in general peritonitis with intestinal paralysis. In ileus without mechanical obstruction he finds atropin sulphate hypodermically, 1 milligramme repeated, of great value. He began using the atropin without faith as a last resort, but has learned its value (has given 5 to 7 milligrammes in twelve to fifteen hours).

After the direct cause of the obstruction has been located and treated, or, if more convenient, before that is done, permit one of the most distended loops of gut to protrude from the belly. Protect the abdominal cavity with hot pads or soft towels. Make an incision into the gut (either transverse or longitudinal) and encourage its contents to escape into a suitable vessel. When the contents cease to escape, clean the wound and close it with a continuous Lembert suture. If necessary, repeat this procedure on other distended loops.* A practical detail which may be of value in carrying out the above is to have a competent assistant assigned to incise, clean, and close the gut, and that for his work he should be provided with instruments, sutures, and sponges entirely separate from those used by the operator. The object of this detail is, of course, that the operator and his first assistant may avoid soiling their hands. The use of rubber gloves which can be changed is of much value.

Before closing the last of the *enterotomy* wounds one may, through it, introduce into the gut an ounce of sulphate of magnesia in solution, or one may inject the solution into the gut by means of a syringe with a suitable cannula, subsequently closing the puncture with one or more stitches.

If the patient is very much collapsed or if it is difficult to find and treat the direct cause of the obstruction, the surgeon should throw aside all ambition to do a complete operation and

* This evacuation is by no means always required. It should be done only if distension is so great that the gut will probably be unable to empty itself in the natural manner.

content himself with bringing the most distended coil of intestine into the abdominal wound and fixing and opening it there (enterostomy). If the patient's strength is equal to the strain, it may be well to precede the enterostomy by evacuating the gut at several places in the manner already described, as the intestine may refuse to empty itself through one opening.

Very many lives have been saved by means of enterostomy which would have been sacrificed had a more complete operation been attempted. When sufficient strength has been gained, the patient must be submitted to a second and radical operation.

Intussusception.—Open the abdomen. Discover the site of the obstruction and attempt to reduce it.

Reduction of the Intussusception.—With the fingers of one hand gently grasp the entering bowel close to the invagination; with the other hand take hold of the bowel immediately below the intussusceptum and gently press, stroke, coax, or milk the intussusceptum upwards. Make no traction or massage. If reduction is obtained, examine the involved gut most carefully, lest it should be injured. If an elongation of the mesentery seems to have had anything to do with the production of the intussusception, it is easy to shorten it by throwing it into folds and inserting a few stitches. If this is done, be careful *not* to interfere with the free passage of blood to the gut through the mesentery. If reduction is impossible, and it frequently is, one may excise the part of gut involved. This is permissible only when the intussusception is limited in extent. The operation is identical with the enterectomy described elsewhere. Instead of enterectomy, the operation of segregation may be employed, or an anastomosis may be established between the open gut above and below the lesion. Under certain circumstances, *e. g.*, prostration, etc., it may be wise to make an artificial anus, whether accompanied by excision of the intussusception or not. The prognosis must always be bad when the intussusception is left unreduced, even though the continuity of fæcal circulation is provided for, as gangrene or inflammation of the involved intestine is liable to occasion a fatal peritonitis.

Volvulus.—Open the abdomen. Find the site of obstruction. Empty the gut by incision. Gently endeavor to unravel the knotted or twisted intestine. If reduction is impossible and there is no interference with the blood-supply of the involved gut, establish an anastomosis between the gut above and below. If the blood-supply is threatened or if for other reasons the step seems proper, excise the involved gut. Where radical treatment is impossible, the operation of intestinal exclusion or segregation may be employed.

Bands, etc.—Bands or strands of omentum, etc., causing obstruction are to be doubly ligated and divided, or rather excised. When dividing such bands, examine them carefully lest they should consist of diverticula with mucous lining, in which case they must be treated in the same fashion as the stump left by the excision of the vermiform appendix.

Adhesions.—The best treatment for obstruction from adhesions, to use an Irishism, is *not* to have the adhesions. The principal *prophylactic* means to this end is, when operating, to leave as few raw surfaces as possible within the belly. Wherever possible, raw surfaces, pedicles, etc., should be covered with peritoneum, even if some plastic work be required for this purpose. Where it is impossible to cover the surfaces with neighboring peritoneum, portions of omentum may be ligated and cut off, and these fragments plastered over the raw surface. Cargile's ingenious membrane is useful for the same purpose and is probably better than the omental graft. The *active* treatment of adhesions is to break them up, either by sharp or blunt dissection, and cover the raw surface as above described. When a gut is adherent to the parietal peritoneum or to an organ of lesser importance, and in freeing it injury to one or the other is probable, be careful to sacrifice the less rather than the more important organ. If it is impossible safely to separate the adhesion, restore the fæcal circulation by establishing an anastomosis between the gut above and below the obstruction.

Foreign Bodies.—For the treatment of obstruction due to this cause see remarks on enterotomy (page 275).

Enterostomy.—The term "enterostomy" signifies an operation to establish a communication between any portion of the intestine and the exterior of the body, whether this opening be used for the introduction of food, etc., or for the evacuation of intestinal contents.

Jejunostomy.—This operation is of value in providing absolute rest to the stomach in cases of hemorrhage when other more direct methods of treatment are unavailable. v. Mikulicz considers jejunostomy "inhuman" when used to prolong life in cases of stenosis from gastric cancer.

The Operation.—Expose and examine the stomach exactly as in gastro-enterostomy in order to prove that some other and better operation than jejunostomy may not be possible. Bring a loop of jejunum, 6 or 8 inches below the duodenojejunal angle, into the abdominal wound and suture it to the fascia and skin. Close the excess of parietal wound. Either at the same sitting or a few days later make an opening into the exposed portion of jejunum of a size sufficient for the introduction of a soft-rubber catheter. Feed with predigested food through the catheter.

An imitation of the Stamm-Kader operation is better. The great objection to this operation is the constant and inevitable escape of bile and pancreatic juice through the fistula. To obviate this evil Maydl, after exposing the jejunum, divides it transversely about 8 inches below its origin; the open end of the upper segment he implants into the side of the lower, about 8 inches below the line of section, and then unites the open end of the lower segment to the skin. The principle is identical with that of Roux's gastro-enterostomy, and is mosst excellent; the only criticism on it is that patients requiring jejunostomy are usually in a very feeble condition and cannot withstand much operative interference.

Instead of the rather complicated Maydl operation, one may make an entero-enterostomy between the afferent and efferent segments, and, if desired, obliterate the lumen of the afferent

segment, by means of a purse-string suture, between the site of the anastomosis and the fistula.

Colostomy (often called Colotomy).—The most common indication calling for colostomy is obstruction, but the operation may be used as a means for the application of remedies (douches, etc.) to the inside of the colon. According to the method of operating adopted, either a part or the whole of the intestinal contents escape through the artificial anus.

Lumbar Colostomy.—The operation is practically the same whether it is done on the right or the left side. The following description applies to the left lumbar colostomy:

Step 1.—Place the patient on his right side with a firm rounded pillow under his right loin. Find a point on the crest of the ilium midway between its anterior and posterior superior spines. From a spot a little in front of, and one inch above, the mid-point of the ilium, make an incision, three to four inches in length, along an imaginary line leading to the junction of the spine and the last rib (Bryant's incision). Divide the skin and subjacent muscles along the whole length of the superficial incision. Attend to hemostasis. Expose and divide the transversalis fascia, exposing the subperitoneal fat.

Step 2.—With blunt dissection penetrate the exposed fat in which the colon is to be found. The colon may always be discovered in front of the lower border of the kidney. Be careful not to open the peritoneum; but if this accident occurs, make use of the opening to aid in locating the colon; which being done, close the peritoneum either by suture or ligature.

Step 3.—Method A: Having found the colon, pull it up into the wound and pass a stout suture through the skin (not the muscles) on one side of the wound, through the colon, and out through the skin on the other side. Clean the lumbar wound and close its deep parts with a few catgut sutures. Close the superficial lumbar wound with silkworm-gut, except opposite the prolapsed gut. Make a small opening into the gut over the suture which traverses its lumen. Pick up and pull out the centre of the suture traversing the gut and divide it. Tie

the two halves of the suture and thus fix the sides of the intestinal opening to the skin. Introduce any more sutures which may be necessary.

Method B: Operate as above, but instead of merely incising the colon, completely divide it, close its lower segment completely, and suture the whole circumference of the upper segment to the skin. (Madelung.)

Method C: Bring a knuckle of gut outside the wound, protect it with dressings, and open it after the lapse of three or four days. Any lumbar wound which is in excess of what is required for the passage of the gut must be closed by sutures. It is unnecessary to fix the gut in the wound by means of sutures.

Inguinal Colostomy.—When the operation is done on the left side, it may be named sigmoidostomy, but the operation is practically the same whether it be a right inguinal colostomy or a sigmoidostomy. A sigmoidostomy will be here described.

Step 1.—Draw an imaginary line from the anterior superior spine to the umbilicus; make an incision two and a half inches long, crossing this line at right angles and distant one and a half inches from the superior spine. One half the cut is above the line and one half below (Harrison Cripps' incision).

Step 2.—Find the colon, recognizable from its longitudinal muscular bands and appendices epiploicæ. Pull it into the wound.

Step 3.—Method A: Pass two silk sutures, two inches apart, through the free margin of the gut. These are for traction purposes and serve as guides. Suture the loop of gut to the edges of the inguinal wound. If the case is urgent, open the gut at once; if there is no urgency, apply dressings and incise the colon after the lapse of three or four days. In this operation there is no attempt made to compel the complete evacuation of the bowel through the artificial opening; much of the colonic contents are at liberty to pass down into the lower gut.

Method B: Gently pull out of the wound as much of the *upper* segment of gut as will come down and push it back again

through the lower angle of the wound. This is done so that the intestinal opening may be made in a part of the gut well supported by mesentery, and thus prolapse be avoided. Introduce traction sutures as in Method A. Suture the protruded loop of gut to the abdominal wound. The sutures should be so placed that at least two-thirds of the circumference of the gut is external to the line of stitches. Open the gut either immediately or after the lapse of three or four days. The object of making so much gut protrude is to form a spur or obstacle to the passage of fæces into the lower segment of bowel.

Method C is almost the same as Method B. After pulling the gut downwards so as to obtain mesenteric support, pass a

FIG. 321.

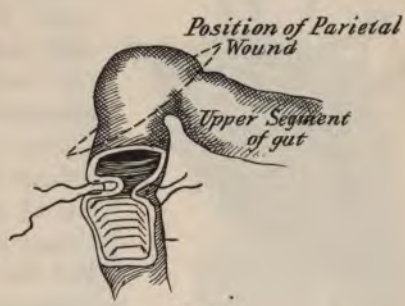


FIG. 322.

glass rod under the selected loop of gut, through its mesentery. The ends of the glass rod rest on each side of the skin-wound and support the loop of gut (Fig. 321). Close the belly-wound, leaving sufficient room for the passage of the loop of gut held in place by the glass rod. Apply dressings. Remove the glass rod and open the gut after union has taken place between the gut and the parietes. This is a convenient and good method.

Method D: Find the colon, pull it downwards so as to provide mesenteric support. Apply clamps to the gut and divide it. Close the lumen of the lower segment by inverting its cut edges and suturing. Suture the whole circumference

to close the artificial anus. When no "spur" preventing the onward passage of fæces is present, all that may be required is to dissect the mucous membrane free from the skin, turn it inwards, stitch its edges together, and then suture the now raw edges of the abdominal wound. When a "spur" is present (*vide* Methods B and C, page 302), one may apply a clamp to the spur and leave it in position until by pressure it causes the "spur" to slough away (Fig. 325). This takes away all opposition to the onward flow of the contents, and the fistula may be closed in the manner already described. Such was the manner of operating devised by Dupuytren, and until comparatively recently was the accepted method. The dangers of the method are: (*a*) peritonitis; (*b*) accidental inclusion of a knuckle of intestine within the clamps. Other and more precise methods are now in use.

The Operation.—Prepare the patient by evacuating the bowels thoroughly forty-eight hours before operation. Immediately prior to the operation give an opiate to keep the bowels inactive for a short time.

Step 1.—Cleanse the skin around the fistula and scrub the fistula itself. Cauterize the fistulous opening with the thermocautery, liquid carbolic acid, or pure formalin. Close the opening tightly with a purse-string suture after packing it with a small plug of gauze. The suture is inserted in the skin, and when tied prevents soiling of the neighborhood by intestinal contents (Fig. 326, L). Once more cleanse the field of operation.

Step 2.—Make an incision through the parietes at a point above, below, or to the side of the fistula, and open the abdominal cavity. In choosing where to make this incision endeavor to find a spot close to the fistula where the tissues are not much altered, and where the viscera are not adherent to the parietal peritoneum.

Step 3.—Introduce the finger into the belly and explore the relations of the adherent gut to the abdominal wall. Guided by the exploring finger, enlarge the incision, making it run around one side of the fistulous opening (Fig. 326, I, N).

Step 4.—Retract the flap formed by the incision I, N. This

exposes the gut and its connection with the inner surface of the parietes at the fistula (Fig. 327, X, Y).

Step 5.—Method A: If the connection between the gut and the parietes is small in extent, empty the gut of its contents by stripping it with the fingers, and keep it empty by suitable clamps. Protect the abdomen with pads; divide the union between the gut and the parietes; close the hole in the gut by a double row of sutures, as is done in enterotomy.

Method B: If the connection between the gut and the parietes when separated leaves such a defect that simple closure would lead to stenosis, either counteract the effect of the stenosis by

FIG. 326.

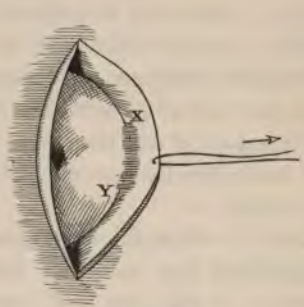


FIG. 327.

anastomosing the afferent and efferent loops or excise the injured portion of gut and restore the continuity of the gut as is done after any enterectomy.

Method C: If the union between the gut and the parietes is very extensive, and if for any reason the above methods are inapplicable,—*e. g.*, presence of extensive and dense adhesions, or the inaccessible location of the fistula,—then the operation of bilateral exclusion may be performed. In this case the next step in the operation, after the exclusion has been accomplished, would be closure of the abdominal wound and removal of the purse-string suture around the fistula, as that opening is required for the

drainage of the excluded segment of gut. A cure of the fistula may be expected, but only after the lapse of much time. The method by "exclusion" or "segregation" is not a method of choice but of necessity, and when done, removal of the mucous membrane from the segregated gut, if possible, is an advantage.

Step 6.—The continuity of the gut having been established, excise the fistula and as much of the surrounding sclerosed tissue as may be necessary to secure healthy structures for suturing. As a rule, in severe cases, the whole of the flap outlined by the cut I, N, Fig. 326, will require removal, and sometimes even more tissue must be sacrificed.

Step 7.—Close the abdominal wound, preferably without drainage.

The operation thus described will generally be found satisfactory. Its extent is rendered necessary from the fact that the fistula is usually surrounded by much scar tissue, which, unless thoroughly extirpated, will almost surely lead to the formation of a post-operative hernia. In a few cases where there is not much deposit of scar tissue and where the fistulous track is short and leads directly into the gut, a much simpler procedure may be adopted.

Step 1.—After thorough cleansing of the fistula and the whole neighboring skin make an incision around the fistula at the junction of the skin and mucous membrane. Through this incision dissect the fistulous track free from its surroundings until the gut is reached.

Step 2.—The fistulous track is now attached to the gut alone, and hangs on it very much as the vermiform appendix hangs on the cæcum after the appendicular mesentery is divided. Remove the fistulous track in the same manner as the appendix is excised and treat the resulting stump similarly.

Step 3.—Close the abdominal wound with or without drainage.

Instead of operating as above, one may open the belly in the middle line, find the loops of gut leading to and from the artificial anus, and make an anastomosis between them, subsequently closing the fistula. In this method it is much easier to keep the peritoneum from being soiled than in the preceding.

When it becomes desirable to close the artificial anus made by dividing completely the gut, closing and dropping its lower segment into the belly, and suturing the upper segment to the abdominal wound, the operation to be chosen is one done on the following lines:

Empty the bowels by means of purgatives or enemata. Administer an opiate shortly before operating to lock up the bowels. Pack the artificial anus with gauze to prevent escape of contents during the operation. Open the belly, preferably in the middle line. Find the lower segment of gut. Find the loop of gut which is attached to the skin and forms the artificial anus. Make an anastomosis between the lower segment of gut and a loop of gut above that which forms the artificial anus. Close or excise the artificial anus either at the same sitting or subsequently. Close the abdominal wound.

CHAPTER IV.

THE VERMIFORM APPENDIX AND PERITONEUM.

OPERATIVE TREATMENT OF APPENDICITIS.

Appendicectomy.—As different methods have been devised for carrying out almost every step of appendicectomy, it may be convenient to describe shortly a number of these methods under the headings Step 1, 2, etc.

Step 1.—*Opening the Abdomen.*—(A) *McBurney Method.*—This method is specially suitable where no drainage of the abdominal cavity is required. Under proper conditions the method is ideal. The principle involved is avoidance of transverse division of muscles or tendinous fibres, so that when healing has taken place there is no post-operative weakness of the belly wall.

The Operation.—Make a three-inch incision through the skin and subcutaneous fat. The cut begins at a point one inch above a line joining the anterior superior spine of the ilium and the umbilicus, and crosses it at a point one and one-half inches from the anterior superior spine. The incision runs downwards and inwards in the same direction as the fibres of the external oblique muscle and aponeurosis. Separate the fibres of the external oblique for the whole length of the wound without cutting any of them transversely. This can be done with the handle of a knife and the finger. With retractors pull apart the edges of the wound in the external oblique and expose the underlying internal oblique and transversalis muscles, whose fibres run approximately at right angles to the superficial wound. With blunt dissection traverse these muscles so as to make a wound in them, parallel to their fibres and at right angles to the wound in the external oblique. Blunt retractors are introduced to keep this

wound open and expose the fascia transversalis, which is divided in the same direction as the wound of the internal oblique. After this the peritoneum is picked up in forceps and opened. Special care has to be taken in opening the peritoneum, as it is frequently found adherent to the cæcum or other abdominal contents. The same rules apply to the opening of the peritoneum as to the opening of the sac in cases of hernia.

Closure of the Wound.—Separate suture of the peritoneum and of the transversalis fascia. The wound in the internal oblique and transversalis muscles requires but one or two points of suture. Suture of the external oblique wound. Suture of the skin. Suture material varies according to the fancy of the operator. The author prefers catgut.

In order to obtain more room Weir, after splitting the fascia of the external oblique, separates it from the anterior surface of the rectus, splits the internal oblique and transversalis like McBurney, but continues the split or incision transversely through the anterior layer of the sheath of the rectus, retracts the rectus itself towards the middle line, and lastly divides the posterior layer of the rectus sheath along with the peritoneum. Closure of this wound presents no special difficulties. Note that in dividing the posterior layer of rectus sheath the epigastric vessels ought to be found and ligated before division.

(B) *Rectus Incision.*—Locate the outer border of the right rectus. Beginning at a point one inch above a line joining the anterior superior spine to the umbilicus, make an incision downwards, about one-half inch internal and parallel to the edge of the rectus. The incision, 2½ inches in length, may be increased if necessary. Expose and split the anterior layer of rectus sheath. Split the rectus muscle *or* retract the muscle (Kammerer) inwards to expose the posterior layer of sheath. Divide the posterior layer of rectus sheath and open the abdomen. This incision is good in almost all cases of appendicitis except when there is a large abscess present and located more or less externally. The wound may be closed in layers or by through-and-through sutures.

(C) *Incision through the linea semilunaris* requires no special description.

(D) *Oblique Incision.*—Locate the outer border of the right rectus muscle. Beginning at a point one inch above an imaginary line joining the anterior superior iliac spine to the umbilicus, make an incision parallel to, and about three-fourths of an inch external to, the edge of the right rectus muscle. This cut runs downwards and slightly inwards for about three inches. The fibres of the external oblique and its aponeurosis can be split longitudinally by blunt dissection; the deeper structures are divided in the direction of the wound. The usual care must be exercised in opening the peritoneum. A good practical rule to adopt in operating is as follows: Make a three-inch incision as above described down to the external oblique; make a small opening through the remainder of the belly-wall; introduce the forefinger to explore; if it is easy to complete the removal of the appendix through the small opening, do so; if not, enlarge the wound to the necessary extent. The size of the skin-wound is of little importance—the smaller the wound of the deep structures (of the *essential* belly-wall), the less danger will there be of hernia. The wound must be large enough to permit of *easy* access to the field of work. After completing the appendicectomy, the wound may be closed in layers or by one layer of sutures traversing the æhole thickness of the belly-wall.

(E) *Inferior or External Incision.*—From a point about two fingerbreadths internal to the right anterior superior iliac spine and one inch above the line joining the umbilicus and the iliac spinous process make a three-inch incision crossing the above line at right angles. Having made the skin-incision, follow the rules laid down for Method B.

Step 2.—Search for and isolation of the appendix.

(A) Digital exploration. The forefinger or, if necessary, two fingers are introduced into the belly and the ascending colon is recognized. The finger follows the colon to the end of the cæcum and is systematically moved about its blind extremity, separating *gently* any adhesions which may be present and which

interfere with the search. If the adhesions are firm or resist the gentle manipulations advised, then the next method to be described must be employed. The appendix may lie in any position near the end of the cæcum and may be either curled up on itself or extended. Having found the appendix, gently separate it from its surroundings and deliver it through the wound. The mesentery of the appendix is transfixed close to the appendix and colon, a ligature drawn through, the mesentery ligated and divided (Fig. 328). If the mesentery is voluminous, it may be necessary to apply two interlocked ligatures. The treatment of the appendix itself belongs to Step 3.

(B) If it proves difficult to find and isolate the appendix by Method A, the wound must be enlarged so that the eye may aid in the exploration. First recognize the ascending colon. This is easily done by noting its longitudinal muscular bands. Follow the anterior muscular band downwards; it leads directly to the base of the appendix. The isolation of the appendix may be accomplished in two ways: If one readily finds its distal end, one begins isolating there and works towards the base. Any rigid adhesions should be ligated with fine silk or catgut and divided. If adhesions to intestines are firm and short, one must remember a cardinal rule in abdominal surgery, viz., sacrifice part of what is being removed, if non-malignant, rather than injure a viscus. If necessary, a thin layer of the appendicular wall (never containing mucosa) may be left attached to a gut so as to avoid laceration of the gut-wall. If it is difficult to find the distal extremity of the appendix, isolation may be begun

FIG. 328.

at its base. It is occasionally necessary to divide the appendix at its base before it can be removed. If this is necessary, one applies a clamp to or ties a ligature around the organ *distal* to the point of section and cauterizes the cut surface. This prevents contamination by the appendix while being isolated and while its cæcal extremity or stump is being treated. Under such circumstances Step 3 is proceeded with before the appendix itself is removed.

Step 3.—Treatment of the stump.

Method A: Tie a ligature tightly around the appendix close to the cæcum. Cut away the appendix about one-fourth of an inch beyond the ligature. Thoroughly cauterize the lumen of the stump with liquid carbolic acid. Wipe away the carbolic acid. This method is simple and gives excellent results. The main objection to the above is that the ligature may possibly be applied beyond a stricture of the appendix, and so there may be recurrence of the disease in the stump.

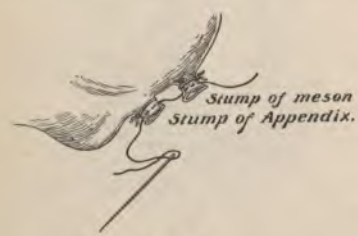


FIG. 329.

Method B avoids the disadvantage pertaining to the preceding method (McBurney). The appendix is divided one-fourth inch from the colon, the edges of the stump are seized with forceps, a probe is passed through its lumen into the colon, its mucous membrane is destroyed by the application either of liquid carbolic acid or the fine point of a cautery. The carbolic acid may be applied by means of a grooved director or by a little cotton tightly wound on a fine probe. Only after the mucous membrane is destroyed does one apply a ligature around the stump close to the colon. This is a thoroughly reliable and simple method. To eliminate the raw surfaces left by this method George Gray sutures the stump of the meso-appendix to that of the appendix itself (Fig. 329).

Method C: At a point about one-fourth of an inch from

the colon a circular incision is made through the serous coat of the appendix, leaving the muscular and mucous coats intact. The serous coat is separated from the muscular up to the colon. Close to the colon a ligature is tied around the tube, composed of muscularis and mucosa, and the appendix removed. The serous cuff is brought forwards over the stump and there sutured (Figs. 330, 331, 332). The method is safe, but cumbrous and unnecessary.

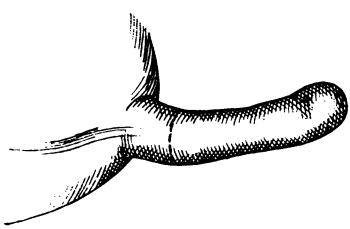


FIG. 330.

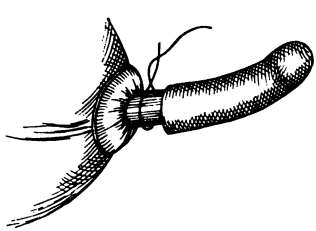


FIG. 331.

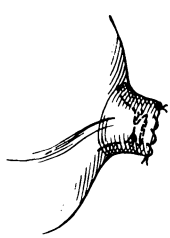


FIG. 332.

Method D: Cut away the appendix flush with the colon and treat the defect as a perforation of the gut—*i. e.*, sew up the hole that is left in the colon by a row of through-and-through sutures covered by a series of continuous Lembert sutures.

Method E: Dawbarn applies a purse-string suture of fine silk or hemp through the serous and muscular coats of the colon around the base of the appendix, and about one-fourth of an inch distant from it (Fig. 333); cuts off the appendix, leaving a stump one-half inch in length; dilates the lumen of the stump

and then invaginates the stump into the colon, at the same time tightening and tying the purse-string suture.

Fig. 333 shows a better method of using the purse-string suture.

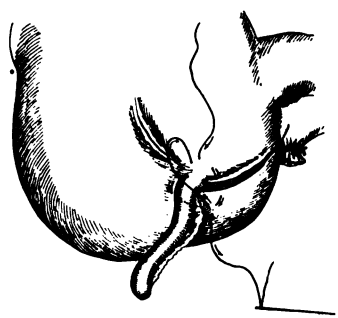


FIG. 333.

The ends of the suture being on opposite sides of the wound, permit better closure of the wound.

Method F: This is a useful variant of Dawbarn's method.

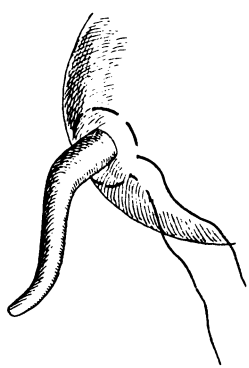


FIG. 334.

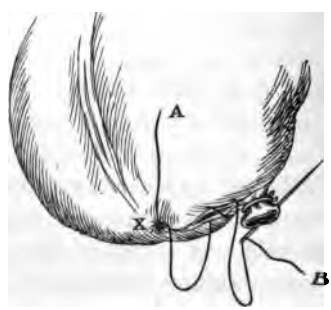


FIG. 335.

Introduce a purse-string suture as in Method E. Clamp the base of the appendix very firmly with a strong clamp. Cut away the appendix flush with the clamp and wipe the cut surface clean. Remove the clamp, which has thoroughly crushed

the included tissues. With a dissecting forceps grasp the stump and push it into the cæcum. Pull the purse-string suture tight and tie. The needle still remains attached to the purse-string suture; with it unite the stump of the meso-appendix to the cæcum at the point of invagination of the remnant of the appendix (Fig. 335).

Step 4.—If there has been no infection outside the appendix, sponge the field of operation with moist pads and close the wound without drainage.

The operation of appendicectomy by any of the methods described in the preceding paragraphs is suitable particularly in cases of chronic or recurrent disease, and in those acute cases subjected to early operation before perforation, or before peri-appendicular suppuration has developed. Although when the abdomen is opened there is no expectation that pus will be met, yet the peritoneal cavity must always be protected by gauze pads while the appendix is being delivered and removed. The young operator is very apt to be afraid boldly to pull the cæcum (when it is not bound down by adhesions) out of the abdomen while he operates upon the appendix. It does no harm to pull out the cæcum, but facilitates the work and renders it safer, besides avoiding a great deal of unnecessary trauma to neighboring intestines which gives rise to much post-operative pain. The whole operation of appendicectomy ought, if possible, to be carried out external to the belly cavity.

Operation in Acute Suppurative Appendicitis without Large Abscess.—The operation is very similar to that for recurrent disease.

Step 1.—Incision B, C, or D (page 311).

Step 2.—Method B (page 311) is advisable, as the aid of the eye is most valuable. During the manipulations necessary for the discovery and isolation of the appendix, the general peritoneal cavity must be protected by pads of gauze placed, inside the belly-walls, around the field of operation. With the same object, to wit, peritoneal protection, it is wise to avoid the separation

of any adhesions which might give protection and yet do not interfere with access to the appendix. While isolating the appendix and breaking down adhesions larger or smaller pockets of pus may be encountered. The contents of such must be carefully removed by sponging before further progress is attempted. The appendix, having been recognized and isolated, is found to be acutely inflamed, generally rigid, often rotten, and sometimes perforated or gangrenous. It must be removed. Its stump must be treated either by Methods A or B or by Method D (page 314). Method D is chosen if the stump is too soft and friable to hold a ligature. The appendix being out of the way, a gentle search is made for other pockets of pus; if such are found, they are treated as already described. The whole field of operation is most carefully cleansed with sponges soaked in normal salt solution. The protective pads surrounding the field of work are removed and replaced by smaller pads of plain or iodoform gauze so arranged that their ends protrude through the wound. Some surgeons leave the original protecting packing *in situ*. If adhesions completely protect the general peritoneal cavity, such pads are, of course, omitted. The whole infected area is *loosely* filled with strips of plain or iodoform gauze the ends of which come out at the wound. As much of the abdominal wound as is not required to provide for drainage and future access to the field of contamination is sutured with silkworm-gut. Very abundant aseptic dressings are applied. When the abscess is of moderate size and has been opened in the usual manner, dangers of post-operative hernia may be minimized by making a second comparatively small opening in favorable position, and through this inserting into the abscess cavity a split rubber tube containing some strands of iodoform gauze. When this is done, the original and necessarily somewhat large incision may be cleansed and closed with sutures. The outer dressings will generally be found soaked with discharge within twelve hours and must then be changed. The loose gauze (not the protecting) packing may generally be left in place for from twenty-four to seventy-two hours. On the whole, loose gauze packing

is preferable to drainage by glass or rubber tubing, though occasionally such may be used.

When to remove the protective packing is still a disputed question. Perhaps the majority of surgeons remove it within seventy-two hours after operation. Crowell long ago recommended leaving the protective packing *in situ* for a week or longer, and such is the practice of the writer. Early removal of the packs is very painful and is liable to break down the barriers which nature is providing for the protection of the belly cavity; late removal is much less painful, as the gauze has become loosened and is therefore not liable to impair the natural defences. The author has frequently left the packing undisturbed, except to loosen its outer portion, for ten days, and never has seen any cause to regret such delay. Of course, watch must be kept for symptoms indicating spread of infection or absorption of dammed-up secretions; if such appear, the wound must be explored and cleaned.

Operation in Appendicitis with Large Localized Abscess.—Access to the abscess is usually obtained by Method E (page 312). This external incision is especially good because the pus must generally be sought to the outer side of the cæcum. When cutting through the parietes, œdema of the tissues may be noticed. If any part of the wound shows more evidence of œdema than another, one may be sure that pus is not far distant, and that the œdematous tissues will act as a guide to it. When the abscess is reached, it must be opened with great care. For this purpose blunt dissection or scratching with a director is safe. The danger of opening some adherent intestine must not be forgotten. A small opening having been made into the abscess, it is enlarged by blunt force. Enlarging the opening into the abscess by means of cutting with scissors or knife is improper if it can be avoided. Many careful surgeons end the operation at this stage, contenting themselves with the introduction of a drainage-tube and perhaps some gauze packing. They apply generous dressings which are soon soaked with discharge and must be changed. The practice is safe. Other surgeons explore the abscess cavity with the finger so as to remove any fæcal concretions or find the

appendix. Often the appendix has sloughed and lies free in the pus. *Great care must be taken to avoid breaking down any adhesions,* otherwise the general peritoneum may become infected. If the appendix is found attached to the cæcum and can be isolated without too great danger, it should be removed and its stump treated as already described. If it cannot be found without prolonged search, or if its isolation would endanger the integrity of the wall of adhesions protecting the peritoneal cavity, most surgeons let it alone. A few operators insist that the appendix should always be removed, but to the writer this appears an eminently unsafe doctrine. The abscess cavity is gently but thoroughly wiped with gauze moistened in warm salt solution, and loosely packed with iodoform gauze, which may surround a rubber drainage-tube. Frequently a sponge stick may be passed from the abscess into the true pelvis, where another pocket of pus may be found. Remember that infection may pass up the ascending colon and give rise to subhepatic, subphrenic, or even pleural suppuration. Abundant external dressings are applied. The after-treatment is the same as that required for any other abscess. To the inexperienced it is astonishing at times to see the amount of pus obtained in such cases when there has been, as is commonly the case, no fluctuation and the tumor has been small. Cases such as have been described very frequently heal slowly, and most stubborn sinuses may persist and require subsequent operation. When healing takes place, the scars are not very resistant to pressure, hence post-operative herniæ are not uncommon.

The foregoing description of operation when large abscess is present presupposes the possibility of gaining access to the abscess without opening the peritoneal cavity. Frequently an abscess forms, is surrounded by adherent intestines, omentum, and a great mass of exudate, but is at no point adherent to the anterior parietes. To gain access to the *tumor* it is necessary to open the peritoneal cavity and the pus must be evacuated by the transperitoneal route. In such cases the abdomen is opened directly over the tumor; the relations of the tumor are discovered

by the finger used with the utmost delicacy; the peritoneal cavity is most carefully and thoroughly protected by pads of gauze; a line of cleavage is found in the tumor and the finger is made to enter the abscess cavity. The opening into the abscess should not be made large *at first* or the whole wound and packing will be flooded by pus. It is desirable that the pus escape so slowly that it can be wiped away at once with gauze. After most of the pus has been removed, the opening into the abscess may be enlarged and the interior cleaned as well as possible with moist gauze. If the appendix is easily found, it should be removed. Now, the abscess may be drained by a tube or loose gauze packing. The protective gauze packs ought *not* to be disturbed, although their outer portions may be partially cut away or cleaned as well as possible. If these packs have served their purpose, while their outer surface is filthy their inner is clean, and before sufficient infection to do harm can penetrate to their inner surface, nature will have thrown around them a barrier of exudate sufficient to protect the peritoneum. If after cleaning the abscess cavity, we take out the filthy-*looking* protective packing and replace it by fresh gauze, we almost inevitably push into the peritoneum a large amount of infective material. The author, except when coerced by symptoms, leaves the protective packing *in situ* for a week or even longer; the loose packing which drains the abscess is, of course, changed as early and as often as may be necessary. When much gauze has been used in the above fashion, it may be impossible to close any part of the wound with stitches. This is of little importance, as it is easy, when suppuration has ceased, to freshen the wound and close it layer by layer with sutures, thus lessening the danger of having a post-operative hernia.

Operation for General Peritonitis Secondary to Appendicitis.—The object of operation is to prevent further leakage of septic material into the peritoneum, to remove as much as possible of the septic material already present, and to provide for drainage. The patients are suffering not merely from inflammation itself, but from shock and intense septic intoxication.

The Operation.—Make a large incision in the right inguinal region over the seat of the appendix. Remove the appendix. Frequently the inflammation has been so acute that no adhesions are present; if there are any, they should be broken down to permit of more thorough flushing. With wet sponges mop away all foreign material, such as fæcal concretions, etc., which may be found in the peritoneal cavity. Systematically douche the peritoneum with a large stream of hot normal salt solution. The solution should be of such a heat that the hand can be kept immersed in it without discomfort (118° F.). The solution may be poured from a pitcher, but it is better to conduct it by means of large tubing to the furthest recesses of the abdomen, so that the flow of contaminated solution may be outwards. When the solution returns clean, the abdominal subcavities—*e. g.*, Douglas's cul-de-sac and the subrenal cavities—are to be gently mopped dry with gauze pads. Drains of iodoform gauze are introduced into the various recesses of the peritoneum and among the intestinal loops. If desired, the gauze strips may be supplemented by glass or rubber tubes leading to Douglas's pouch, etc., or counter-openings may sometimes be made on the opposite side or in the loins. Abundant septic dressings must be applied. The external dressings will be found soaked with discharge in a few hours and must be changed. The iodoform gauze drains are not removed for at least forty-eight hours. If a glass tube has been used, it must be aspirated at intervals of a few hours and removed generally in thirty-six to forty-eight hours.

Joseph A. Blake ("Transactions Am. Surg. Association," 1903) advocates early operation; lavage of the peritoneum with large quantities of saline solution; closure of the peritoneal cavity *without* drainage, unless the latter is absolutely indicated by the presence of non-absorbable amounts of necrotic material. Blake's published results are remarkably good. One of the gravest dangers in generalized peritonitis is the absorption of toxins into the circulation. The peritoneum of the upper part of the abdomen has greater absorbing power than that of the lower, hence to let gravity aid in drainage and to hinder absorp-

tion as much as possible Fowler recommends that patients be kept in an inclined position, the upper end of the bed being raised. The principle of this is admirable and good results have followed its use by various surgeons.

A method of operating followed by some surgeons in cases of early generalized peritonitis is to open the abdomen in or near the middle line. Guided by the hand inside the abdomen it is easy to make an opening about 1½ inches in length in each inguinal region and through these to insert split rubber tubes containing strands of iodoform gauze. Rapidly cleanse the abdomen with salt solution and close the median wound. Return the patient to bed and keep him propped by bed-rest and pillows in a greatly exaggerated Fowler position. The results obtained are said to be excellent.

When ought one to advise operation in appendicitis?

Many surgeons answer the above question in a most simple manner by saying, "When appendicitis is diagnosed then is the time to operate." Most surgeons are less radical. All surgeons approve of operating in the interval between attacks of chronic or relapsing appendicitis. In acute appendicitis all surgeons approve of operating while it is reasonable to suppose that the infection is confined within the appendix itself—*i. e.*, within thirty-six or even forty-eight hours of the beginning of the attack, *but the earlier the better.* All are agreed on the necessity of evacuating abscesses when symptoms of absorption are grave or increasing. In all other cases marked differences of opinion exist. The author's personal views are as follows, and are those common to many other operators:

1. If possible, operate within forty-eight hours of the inception of the disease. Within twenty-four hours is better than forty-eight, and within twelve hours is better than twenty-four. *The earlier the better.*

2. After the lapse of forty-eight hours it is safer to adopt Ochsner's plan of non-operative treatment. (Ochsner, "Clinical Surgery: the Treatment of Appendicitis.") This consists in—(*a*) Rest in bed. (*b*) Avoidance of purgatives. (*c*) Absolute

denial of food and drink to the stomach. (*d*) If nausea or pain is present, lavage of the stomach. (*e*) Exclusive rectal alimentation (one ounce of concentrated predigested food in three ounces of salt solution, every four hours). The exceptions to this rule are cases in young children and in the aged. The former cannot give the assistance necessary; stomach lavage in them means a fight and consequently much danger from spread of infection. Further, the omentum in children is small and can do little to wall off the focus of infection. The aged beat confinement in bed badly and as a rule the whole treatment outlined is inapplicable to them. In these cases the surgeon should watch the case carefully and if improvement does not set in *promptly* or if the symptoms get worse, he should operate.

3. After the subsidence of the acute attack, where the temperature and pulse have become normal, when pain, tenderness, and muscular rigidity have disappeared and the bowels are acting well, without causing disturbance, then the interval operation ought to be performed. Many surgeons advise that a certain *definite* time be allowed to elapse between the attack and the interval operation, *e. g.*, four weeks, to permit of complete restitution of the normal conditions. This is a safe precaution, but a careful observer is able to form an opinion of his patient's condition and operate when he thinks right without adhering to any such strict rule as to lapse of time.

4. When the case is seen too late for the early operation, and tumor is present and the pulse, temperature, and general condition of the patient indicate a dangerous amount of absorption. If the tumor is increasing markedly and there are signs of the infection spreading, no surgeon would hesitate as to operation. Interference is imperative. When, however, the tumor is not increasing or is decreasing and the temperature and pulse are moderate and in proper relation to each other, there is, on the whole, less danger in delay than in immediate operation. Such cases almost always improve under the Ochsner regimen to such an extent that at a safe interval operation becomes possible.

The danger of immediate operation is not merely that of shock and of general peritoneal infection, but the manipulations necessary for the evacuation of the encapsulated pus inevitably open up channels by which toxins are absorbed in quantities which may be fatal. Nature, when aided by rest, can safely encapsulate, and ultimately remove, even considerable quantities of pus in the peritoneum. If at any time during the course of the disease it becomes apparent that the encapsulation is incomplete and that dangerous amounts of toxins are being thrown into the circulation, then immediate operation becomes imperative. The author is perfectly aware that this advice violates the great law "*ubi pus ibi evacuo*," and will not meet with the approval of the majority of surgeons, but its importance has been impressed on him by experience.

5. In cases of appendicitis with generalized peritonitis the general rule is to operate once and thoroughly. Very excellent results have been obtained in this way by many thoroughly reliable surgeons. The author is compelled to admit that his recoveries have been few in the cases on which he has operated under these conditions, while of the cases which refused operation a considerable number (too many to be all examples of mistaken diagnosis) have recovered most unexpectedly. Since adopting the Fowler or, better, the exaggerated Fowler position during after-treatment, the writer's results have improved immensely.

TUBERCULOUS PERITONITIS.

When tuberculous peritonitis is not a mere phase in the history of a general tuberculosis, it is usually a reaction against infection coming from a tuberculous Fallopian tube; from a tuberculous stenosing ulcer of the ileum; from a tuberculous tumor of the ileum and cæcum; from a tuberculous vermiform appendix. Tuberculous peritonitis is much more common in the female, as the Fallopian tubes are the favorite sites for primary intra-abdominal lesions.

Accidentally it was found that mere abdominal incision and evacuation of any ascitic fluid present, with or without subsequent drainage, led to recovery in many cases. Veit believes that 50 per cent. of the cases were cured and 25 per cent. improved after the above treatment, the curative agent being serum, effused as a result of the operative interference, acting as an antitoxin.

The most favorable cases were those in which ascitic fluid was *removed* during the operation, hence it is difficult to imagine the above theory correct. J. B. Murphy observed that where the end of the diseased Fallopian tube was patent, peritonitis was progressive, and where the ostium was closed by adhesions, etc., the peritonitis became stationary or was cured. Mayo came to the conclusion that in the presence of ascites the fimbriated extremity of the tube was mechanically kept patent, the fimbriæ being kept from adhering to each other and to neighboring structures, and hence the infective contents of the tube could constantly or intermittently leak into the peritoneal cavity. This gives a feasible explanation as to why simple laparotomy with removal of ascitic fluid often results in the cure of tuberculous peritonitis; the end of the tube, no longer buoyed up by the fluid, becomes closed, either by the fimbriæ adhering to each other or to neighboring structures. The primary lesion thus becomes encapsulated, and the peritoneum, being very resistant to tuberculosis, recovers. It has long been known that the cases accompanied by ascites are the ones most benefited by surgical interference. Primary tuberculous lesions in the ileum have a great tendency towards spontaneous recovery; in these, when operation is demanded, it is to overcome resultant stenosis.

The tumor-like tuberculosis of the ileo-cæcal region has likewise a predisposition to cure. Both in the case of disease of the ileum and of the ileo-cæcal region the presence of ascitis is well calculated to prevent the formation of protective adhesions around the focus of disease, hence the simple removal of the fluid may result in efficient encapsulation of the primary focus.

Operative Treatment.—It is presumed that the diagnosis of tuberculous peritonitis has been made, but the site of the primary lesion is unknown.

Step 1.—Open the abdomen, in the female, by median, in the male, by the right rectus, incision. Evacuate any fluid which may be present.

Step 2.—If in the female, examine the Fallopian tubes. This must be done with enormous caution in the presence of many adhesions, as it is easy to tear into a gut. If the necessary manipulations are very difficult, the dangers from injury to the gut outweigh the advantages of a radical removal of the primary focus, and it will be wise for most surgeons to trust to the encapsulation of the disease which is likely to result.

If safe, removal of the tubes is, of course, the procedure of choice. In any case examine the favorite sites of tuberculous lesions. Remember that what may appear a simple chronic appendicitis may be tuberculous, and that with the appendix any enlarged glands in the mesenterolium ought to be removed. When there is a stenosing ulcer of the ileum, an anastomosis between the afferent and efferent segments of gut is all that is commonly required. If the diseased segment of gut is limited in extent and easily excised, its removal is proper, though not imperative.

The tumor-like tuberculous lesion of the ileo-cæcal region ought to be excised if this is fairly easy; if difficult, then that segment of the gut may be "segregated" (see page 293) or left to the curative powers of nature, assisted by the abdominal incision.

M. H. Richardson writes: "When, therefore, I have found a tuberculosis limited to a single coil of intestine, rather than excise that coil, except when stricture is present, I have contented myself with the exploration and demonstration of the disease. If the area affected has been one that could be easily and safely removed, I have removed it, as in tuberculosis limited to the appendix or to the Fallopian tubes."

Any tuberculous abscesses encountered should be evacuated dried, iodoformized, and *not* drained.

Step 3.—Close the abdomen, preferably without drainage. The use of a drain is liable to lead to secondary infection and fæcal fistula.

CHAPTER V.

THE RECTUM.

Imperforate Anus.—There are two forms of imperforate anus: (A) No anal depression is present; (B) an anal depression is present, but does not open into the rectum.

(A) The anal depression is absent.

The Operation.—Place the child in the lithotomy position. Draw off the urine with a catheter. Do *not* keep the patient *deeply* anæsthetized, as its attempts at crying and struggling press the gut downwards and aid the surgeon in recognizing the gut when he approaches it. Of course, enough anæsthetic should be given to prevent suffering.

Step 1.—Make an incision in the median line from the middle of the perineum to the tip of the coccyx. Penetrate the skin and the musculo-aponeurotic floor of the pelvis. Frequently the gut will now present and be recognized from the dark blue color given it by the contained meconium. If the gut is not found, retract the walls of the wound. Note the position of the bladder—if necessary, introducing a sound into the bladder for this purpose. Deepen the wound by blunt dissection, following the concavity of the sacrum to its promontory. If the external wound is too small to permit of such deep dissection, continue the original incision backwards over the lower end of the sacrum and excise the coccyx and lowest segment of the sacrum. When the neighborhood of the gut is reached, if the child cries, an impulse will be communicated to the palpating finger. If the child is too deeply anæsthetised to cry, intermittent firm pressure on the abdomen may give the same result. The gut having been found, separate its lower end as freely as possible from its surroundings.

Step 2.—When the gut is found to be superficial, seize it with a couple of small volsellum forceps or pass a suture through it

for purposes of traction and pull it downwards to the skin, separating its lateral adhesions as traction is being made. With a knife cut into the gut. Meconium at once escapes and must be washed away by a stream of warm water. Clean out the gut by means of injections of warm water until the water returns clear. Cleanse the wound with a mild antiseptic solution.

Step 3.—Carefully and accurately suture the opening in the gut to the skin with interrupted sutures. Close the remainder of the wound with such deep and superficial sutures as may be required.

When the gut is more deeply situated, the technique is rendered much more difficult. It may be impossible to bring the gut down to the skin before evacuating its contents. In such a case, fix the gut with sharp hooks or forceps, open it with a knife, and by means of a catheter douche out its contents. When the gut has been emptied, it is often possible to separate it from its lateral connections and bring it down to or near to the skin. When possible, the edges of the opening in the gut must be accurately sutured to the skin, as already described.

Should the rectum be entirely absent, the pertoineal cavity may be opened through the perineal wound and the first loop of gut which presents (generally the sigmoid) brought down, opened, and sutured to the skin (Stromeyer). In case of failure to find the lower end of the rectum through the perineal route Macleod recommends that the abdomen be opened, the lower end of the *blind* rectum found, rendered mobile, and pushed downwards into the perineal wound, where it is treated in the manner already described.

(B) The anal portion of the gut is present, but is not joined to the rectum.

By palpation and inspection find if there is only a thin diaphragm separating the rectum from the anal gut or depression. If this is so, perforate or excise the diaphragm. If, as is often the case, much tissue is interposed, make an incision in the middle line from the anal depression or gut to the coccyx, deepen the incision as may be required, and proceed as if no anal gut was present, except that after the rectum has been opened and evacu-

ated, its opening should be sutured to the anal gut instead of to the skin.

When none of the methods described is successful, or if the condition of the patient is such as to render them too risky, it is proper to make a permanent or temporary artificial anus in the inguinal or lumbar region. Should it seem advisable, the perineal operation may be attempted at a later date.

Prolapsus Recti.—Rectal prolapse may be of two forms: in one form the rectal mucous membrane alone is protruded through the anus; in another, the rectal walls are more or less prolapsed. The prolapsed tissue may be reducible or irreducible; in the latter case it generally shows evidences of past and present inflammation. The prolapse may be due to atony or dilatation of the sphincter, or to a lack of support to the gut from above. Prolapse may be an accidental concomitant of a rectal tumor, the weight of the tumor dragging the gut down. Comparatively recently the main active treatment of rectal prolapse consisted in chemical or thermal destruction of protruding mucous membrane or of portions of the dilated anus, the scar contraction incident to healing leading to narrowing of the anus and support of the gut. Strangulation of the protruding tissues by means of ligatures was also recommended and often gave good results. All such measures ought to be discarded, as chemical and thermal action are difficult to regulate and the strangulation by ligature is distinctly dangerous. There are three distinct principles, each of which is the base of a modern method of operative treatment:

1. When the prolapse is due to sphincteric atony or looseness, the principle of treatment is to overcome this condition by narrowing the sphincter.

2. When the prolapse is due to want of superior support, such support must be provided.

3. When there is excess of rectum and much tissue is prolapsed, the protruded mass should be excised. Generally this excision must be supplemented by narrowing the sphincter.

It must be remembered that very many cases of prolapse, and in children even severe cases, may be cured without operative interference.

Plastic Operation on the Sphincter Ani.—I. *Duret's Operation.*—From the posterior surface of the rectum remove a triangle of mucous membrane. The base of the triangle is at the mucocutaneous junction; the apex is directed up to the gut. From the skin behind the anus remove a similar triangle having the same base as the former, but having its apex directed towards the coccyx. A lozenge-shaped raw surface is thus formed partly involving the skin and partly the mucosa. By deep dissection cut away a wedge of the tissues exposed by the removal of the skin and mucous membrane. With the wedge of tissue a portion of the sphincter is excised. Insert deep and superficial sutures and close the wound. It is a wise precaution to unite the divided ends of the sphincter by one or more interrupted buried catgut sutures. In one case of particularly flaccid anus Duret has performed the above operation both posteriorly and anteriorly. The operation must be done under the most painstaking antiseptic technique. This is of great moment in all the plastic operations about the rectum and anus.

II. Duret's operation may be modified as follows: Make a curved transverse incision following more or less closely the mucocutaneous junction at the posterior side of the anus. Through this incision, with scissors or knife, dissect the mucous membrane from the posterior anal wall until a point is reached above the sphincter. Excise a sufficiency of the sphincter and with catgut sew the divided ends together. If necessary, excise a portion of the reflected flap of mucous membrane. Close the superficial wound. This operation is only feasible if the prolapse can be reduced.

Operations to Narrow the Rectal Lumen and thus Prevent Prolapse.—Lange's Operation (*Transverse Rectorrhaphy*).—Make an incision in the middle line from a point immediately behind the anus to the base of the coccyx. Do *not* injure the sphincter. Resect the coccyx. By dissection expose the posterior surface of the rectum. Introduce a number of sutures into the gut wall in the Lembert fashion, transversely, as if closing a longitudinal tear in the rectal wall. The sutures must *not* penetrate the mucosa. Tie the sutures. The result is to narrow the gut by

throwing its posterior wall into a longitudinal fold. Close the external wound by deep and superficial sutures.

Rectopexy.—(A) *Verneuil's Operation.*—With a knife trace a triangle having its base at the anus, its apex at the tip of the coccyx. Excise this triangle of tissue and with it the whole segment of sphincter corresponding to its base. Pass a long suture transversely through the posterior wall of the exposed rectum, without penetrating the mucosa. Arm each end of the suture with a needle. Push the needles through the tissues of the back, from within outwards, to emerge through the skin, one on each side of the sacro-coccygeal articulation. At lower levels introduce three other sutures in a similar manner. Tie the sutures. This narrows the anus and pulls the lower rectum backwards and upwards.

(B) *Marchant's Operation.*—Expose the posterior surface of the rectum by means of a median incision from behind the anus to the tip of the coccyx. Introduce several rows of sutures in the long axis of the gut after the Lembert method, as if to close a series of transverse ruptures of the gut. The sutures must not penetrate the mucosa. As each row of longitudinally placed sutures is tied the posterior wall of the gut is thrown into a series of transverse folds, which shortens it. With catgut unite the lowermost fold to the tissues immediately in front of the coccyx. Give additional support by introducing one or more sutures after the method of Verneuil described above. Close the wound completely.

Colopexotomy (*Jeannel's Operation*).—The object of this operation is to attach the sigmoid flexure to the abdominal wall and so give superior support to the rectum. The scope of the operation must be limited. In Garrè's clinic 59 per cent. of relapses followed the operation or some modification of it. (Pachnio, "Beiträge z. klin. Chir.," xlv, 300.)

The Operation.—Open the belly as in left inguinal colotomy. Seize the sigmoid flexure and pull it up until the rectal prolapse is reduced. Suture to the abdominal wound the lowest portion of the gut which can conveniently be brought into it after re-

duction of the prolapse. Make an artificial anus. After the gut is securely attached to the abdominal wall, and the rectum, irritated and inflamed because of having been prolapsed, is healed, the artificial anus may be closed.

Excision of the Prolapsed Gut.—A considerable number of methods have been devised for the removal of the prolapsed mass. Several of the methods fail to recognize the existence of a peritoneal pouch between the inner and outer tube of the intussuscepted gut and that a loop of small intestine may be present in that pouch. This failure renders all such methods too dangerous to be justifiable, and they will not be here described.

Mikulicz's Operation.—Place the patient in the lithotomy position at the edge of the table. Make a horizontal incision through the anterior half of the external tube or cylinder of gut, *i. e.*, into the peritoneal pouch. Explore the pouch with the finger and reduce its contents if there are any. Suture, by the Lembert method, the peritoneal surface of the outer tube to that of the inner tube (Fig. 336). Cut away the gut corresponding and peripheral to the line of suture. Cover the line of suture by a row of stitches uniting the mucous membrane of the outer to that of the inner tube. The posterior half of the prolapsed gut must now be attacked in the same manner and the outer and inner tubes united by a row of Lembert sutures protected from contamination by some stitches which involve the mucosa alone.

FIG. 336.
O.T. Outer tube of gut. I.T. Inner tube of gut. P. Peritoneum. S. Sphincter ani. X. Suture.

To be successful the above operation must often be supplemented by a plastic operation on the sphincter such as has already been described.

Stricture of Rectum.—I. When a rectal stricure is soft and can be reached through the anus, treatment by gradual dilatation should be attempted.

Introduction of Rectal Bougies.—Place the patient on his left side with the right thigh partially flexed. Introduce the index finger through the anus and locate the opening through the stricture. If the stricture is large enough to permit the passage of the finger without force being employed, the finger may be used as a bougie. If the stricture is either narrower or much wider than the finger, use the finger as a guide and pass a well-oiled soft-rubber rectal bougie through the constriction. *No force must be used.* Leave the bougie in place for two or three minutes and withdraw it. Repeat the operation after the lapse of from one to four days, *i. e.*, after any irritation produced by the operation has subsided. At each operation it may be necessary to pass several instruments of different sizes, the last one being the largest which it is possible to introduce through the constriction without force. The principle of treatment is identical with that of gradual dilatation of urethral stricture. As in the case of the urethra, some rectal strictures are too irritable to permit of gradual dilatation. When suitable, the treatment is safe, but it is only palliative, as the contraction recurs when dilatation is discontinued.

II. *Credé's Operation.*—If the stricture is firm and resistant to gradual dilatation, Credé's operation may be useful. Administer an anæsthetic. Guided by the finger, pass a probe-pointed knife through the stricture and with it make a number of small cuts or "*nicks*" in the protruding edge or ring of the stricture. Six or eight of these cuts may be made, none of them deep enough to endanger the peritoneum. Remove the knife and gently introduce a bougie. The rest of the treatment is that of gradual dilatation.

Forcible dilatation has been practised, but has proved too brutal and dangerous. It is unjustifiable.

III. *Posterior Rectotomy.*—Place the patient in the lithotomy position. Guided by the finger, pass a probe-pointed bistoury through the stricture and divide it completely in the middle line posteriorly. Continue the incision downwards and backwards so as to divide the sphincter ani. The result of this cut is the

division of the stricture, the rectal wall below the stricture, and the sphincter, in the posterior median line. Attend to hemostasis. Pack the wound. The after-treatment consists in frequent changes of dressings, in careful cleansings, and subsequently in the use of rectal bougies.

IV. *Pean's Modification of Posterior Rectotomy.*—Make an incision in the middle line of the posterior wall of the rectum from a point three-fourths of an inch above the stricture to and including the sphincter ani. Continue the incision backwards in the middle line until the incision through the skin equals in length that through the mucous membrane of the rectum. Pull the mucous membrane at the upper angle of the wound downwards and suture it to the skin. To render the mucous membrane movable, it may be necessary to undermine it slightly. The principle of the operation is to convert the original vertical wound into a transverse one and so gain room.

V. *Sonnenburg's Operation.*—Expose the gut by Kraske's method (page 340). Divide the stricture, vertically, taking care to avoid injuring the sphincter. Pack the wound. Healing takes place very slowly; fistulff are almost certain to persist, and after-treatment with bougies is necessary.

VI. *Sokoloff's Operation.*—This operation is the same as Sonnenburg's, but instead of packing the wound, the vertical incision is converted into a transverse one by means of sutures. In suitable cases this operation is one of much promise, but cases suitable for it must be exceedingly rare.

VII. *Excision of the Stricture.*—The stricture may be excised in various ways. The methods of rectal incision are described elsewhere. It was hoped that excision, though dangerous, might prove an entirely reliable means of treatment. Experience seems to show that it is little better than a means of palliation.

VIII. *Colo-rectostomy.*—When the stricture is seated high up in the rectum, an anastomosis may be made between the colon and the rectum so that the intestinal contents may pass around the stricture.

IX. *Colotomy* may be used in the treatment of rectal stricture

for two purposes: (*a*) To give relief from the obstruction; (*b*) to give rest to the rectum and to permit of local operations or treatment being carried out without interruption from fæces. In this case after the rectal disease has been cured the artificial anus may be closed.

The methods of performing colotomy are described elsewhere (page 301).

Excision of Rectum.—Excision of the rectum is most commonly indicated in cases of malignant tumors. When performed for the relief of rectal stricture (non-malignant), the operation is identical, except that in this case it is not necessary to excise the disease so extensively.

Preliminary Treatment.—Two main indications must be observed, viz.: (1) Improve the general condition of the patient; (2) diminish the septicity of the intestine.

The general condition may be improved by means of proper regulation of the organs of elimination and of proper regulation of the diet. A diet of eggs and milk is highly to be recommended. How may the septicity of the gut be diminished. The only efficient medicinal means of cleansing the rectum is purgation. But it is easy to carry this means too far and weaken the patient. The moderate use of salines or of calomel is highly proper. Various antiseptics have been administered by the mouth, in the hope of lessening the filthiness of the rectum (resorcin, salol, etc.), but in the opinion of the writer such endeavors must be as futile as an attempt to antisepticize the Mississippi River at New Orleans by pouring a barrel of corrosive sublimate into its current at St. Paul.

Apart from moderate purgation, the only possible means to approximate cleanliness in the lower bowel is flushing and scraping.

Flushing the Rectum.—Pass a long, soft, flexible rubber tube into the rectum and through the stricture. Through a funnel on the proximal end of the tube pour warm water or boracic acid solution into the gut until the patient experiences a feeling of discomfort. Lower the funnel and tube, and permit the water to flow into a receptacle on the floor. Repeat the operation.

Carry out these rectal flushings every morning and evening for four or five days before the operation.

Scraping the Rectum.—Immediately before the operation dilate the anus and scrape away all the friable surface of the cancerous growth with a sharp spoon, preferably with a flushing curette. The bleeding is trivial and soon stops. Should the hemorrhage not cease spontaneously and quickly, touch the bleeding points with a thermo-cautery or with liquid carbolic acid, preferably the former. Removal of the abominably foul surface of the cancer with a curette and thorough flushing of the rectum are undoubtedly the best means of diminishing the septicity of the bowel, but however thoroughly these means are used, the cleanliness obtained is only relative, though none the less important.

I. *Vaginal Route.*—In the female, when the anterior rectal wall alone is diseased, one may make a vertical incision through the posterior vaginal wall, expose the growth, excise it, suture the opening left in the rectum, and then separately suture the vaginal wound. Such an operation is not often suitable.

II. *Anal Route.*—(A) The anus is involved in the disease. Place the patient in the lithotomy position. Make an incision all around the anus. With blunt and sharp dissection separate the diseased anus and the rectum from their surroundings until a point in the rectum is reached about one and one-half inches above the disease. Divide the rectal tube at this point and remove the disease. Attend to hemostasis. Pull the edge of the divided rectum downwards and suture it to the skin, if possible. If the incision surrounding the anus does not give sufficient room for the next steps of the operation, one may supplement it by a median incision running backwards to the coccyx or one may even excise the coccyx. If it is impossible to bring the divided end of the rectum down to the skin at the site of the natural anus, it may be sutured to the skin at the level of the coccyx.

The operation as described is permissible only if the anus is diseased. The sphincter is sacrificed. Incontinence of fæces

results. Delbet writes: "To avoid these inconveniences Witzel, on the advice of Willems, passes the end of the rectum through the fibres of the gluteus maximus, Rydygier through the pyriformis and gluteus maximus, Gersuny, before fixing the rectum, so twists it on its axis that its longitudinal muscular fibres play the rôle of sphincter, or at least offer some mechanical opposition to the escape of intestinal contents."

(B) The anus is *not* involved in the disease.

1. The disease is freely movable and only involves a small part of the rectal wall. Place the patient in the lithotomy position. Dilate the anus fully. Seize the tumor with a volsellum and pull it downwards into a freely accessible position. On each side of and a little above the tumor seize the rectum with forceps or sharp hooks. The object of this is to prevent the wound being retracted out of easy reach after the tumor is removed. Freely excise the tumor. Close the wound with sutures after attending to hemostasis. When possible, it is wise to insert the sutures in the long axis of the gut so that the resulting scar is transverse and danger of subsequent stricture is lessened.

2. The disease is freely movable, is *very low down* in the rectum, but involves all or nearly all the circumference of the gut. Place the patient in the lithotomy position. Dilate the anus fully. Seize the tumor with volsellum forceps and pull it downwards into a freely accessible position. Make an incision completely around the anus at the muco-cutaneous junction. Separate the anal mucous membrane from the sphincter. When the upper edge of the sphincter is passed, divide the whole thickness of the rectal wall and separate the rectum from its surroundings until a point is reached well above the disease. In cancer remove too much rather than too little. Attend to hemostasis. Divide the rectum above the disease and remove it. Pull down the divided end of healthy rectum and suture it to the skin.

III. *The Perineal Route.*—Place the patient in the lithotomy position. Make an incision in the middle line from the anus to the point of the coccyx. This incision divides the sphincter. Dieffenbach supplements the above cut by one placed in the

middle line anteriorly which also divides the sphincter and reaches to the bulb of the urethra. Retract the edges of the wound. Separate the anal mucous membrane from the sphincter and proceed to remove the disease as described in the preceding paragraph. In dissecting the rectum free from its surroundings take special care not to injure the prostate or the base of the bladder; for this purpose it is wise to do most of the dissection with the

FIG. 337.

A, B, C, Kraske's line of section. H, K. Heineke and Kocher's line of section.

finger or some blunt instrument. Should the bladder be torn, its wound must be closed at once by a few sutures.

The disease having been removed, pull down the divided end of the healthy rectum and suture it to the anal skin. Close the rest of the wound with deep and superficial sutures. The stitches should restore the integrity of the sphincter and do away with the presence of dead spaces in the depth of the extensive wound.

If it is impossible to avoid the presence of dead spaces, such must be drained.

If, in order freely to excise the tumor it is necessary to open the peritoneum, do so, but before penetrating that cavity carefully wash the wound with an *antiseptic* solution and close the peritoneal wound with sutures at as early a stage in the operation as possible.

IV. *Sacral Route.*—Every method by which the rectum is removed via the sacral route is based upon the Kraske operation.

Kraske's Operation.—Place the patient on his right side with the thighs slightly flexed.

Step 1.—Make an incision in the middle line from the middle of the sacrum to the anal margin. This cut penetrates to the bone but does not cut through the anal sphincter.

Step 2.—Detach the gluteus maximus on the left side from its sacral and coccygeal origins.

Step 3.—Excise the coccyx.

Step 4.—Close to the sacrum, cut through the lower part of the left sacro-sciatic ligament.

Step 5.—With chisel or strong bone forceps excise the left half of that part of the sacrum lying below the level of the third posterior sacral foramen * (A, B, C, Fig. 337).

Step 6.—Expose the rectum by dividing the soft structures lying between it and the sacrum. *Do not open the gut.*

Step 7.—Separate the gut from its surroundings by blunt dissection. The rectal mesentery having been loosened (bluntly), pull the gut downwards to such an extent that after the diseased section has been freely removed the continuity of rectum may be restored by sutures on which no unnecessary tension must be exerted. It is important not to have opened the gut, as in this step of the operation the peritoneum is frequently opened either

*Step 5 of Kraske's operation is frequently modified. It is found that much more of the sacrum may be removed, when necessary, than has been described above. The left half of the sacrum up to the second foramen has been excised, the spinal canal opened, and the lower fibres of the cauda equina removed without evil resulting.

by accident or design. If the gut is not opened and the tumor not invaded, the peritoneum must be closed by sutures or packing (preferably by sutures) after the rectum has been pulled downwards to the desired extent. If the peritoneal wound has become soiled, owing to escape of intestinal contents from an accidental tear in the gut, it must be cleansed and drained with iodoform gauze.

Step 8.—At a point about one and one-quarter inches above the disease (if it is malignant; closer, if non-malignant) divide the gut transversely and remove it to a point the same distance below the disease. Suture the upper segment of gut to the lower.

Step 9.—Cleanse the whole wound carefully. Diminish the size of the wound by a few stitches so applied as to avoid interfering with the freest possible drainage. Pack the rest of the wound loosely with iodoform gauze. The wound closes by granulation. A fæcal fistula frequently results, as the intestinal sutures, especially the posterior ones, commonly give way.

Rehn's Modification of Kraske's Operation.—Instead of Kraske's median incision make a cut along the left side of the sacrum and coccyx and continue it towards the anus (A B, Fig. 338). If sufficient space is obtained by this incision, proceed with the other steps of the operation. If more room is required, make a transverse incision (B C, Fig. 338) over the sacrum between the third and fourth sacral foramina. Separate the sacrum from the soft parts in front of it and divide the bone along the line of the transverse incision. Reflect the newly formed flap, consisting of sacrum, coccyx, and soft structures covering them, to the right.

The rest of the operation is practically identical with Kraske's, except that after the rectum is loosened from its connections and pulled down so far that suture of the divided ends (without tension) will be possible after the tumor is removed, the whole wound is loosely packed with iodoform gauze and the rectum left unopened and not relieved of the tumor. During the after-treatment the patient must lie on his side. Keep the bowels locked up for five days with opium. On the fifth day move the bowels with castor oil and enemata. After the lapse of about

ten days from the primary operation, excise the tumor and suture the ends of the gut together. In doing so, first stitch the mucosa with catgut and then unite the other coats with silk. It strengthens the line of sutures if the silk stitches include in their bite some of the neighboring soft parts.

It is claimed that, among other advantages, the operation in two stages lessens the immediate mortality of a very serious pro-

FIG. 338.

cedure—(*a*) because the shock is lessened, (*b*) because the huge wound cavity is well covered by granulations before there is much chance of its becoming soiled by intestinal contents.

A distinct disadvantage of Kraske's operation is that the levator and the sphincter ani muscles lose the support which they normally obtain from the sacrum and coccyx. This is important for the future comfort of the patient. In order to save the sacrum and coccyx Heineke and Kocher (Fig. 337) have divided the coccyx

and lower end of the sacrum longitudinally in the middle line and retracted the fragments to either side, replacing them when the operation was completed. Schlange has attained the same object by a method which affords much room and has given excellent results in his hands.

Schlange's Operation.—Step 1.—Make a transverse incision down to the bone across the lower part of the sacrum.

Step 2.—From the above incision make two others (one on each side of the coccyx) which diverge from each other slightly and end near the level of the anus. Near the anus these two cuts merely penetrate the skin, but where they skirt the coccyx and lower end of the sacrum they divide the muscles and ligaments inserted into these bones.

Step 3.—With a Gigli wire saw divide the sacrum transversely along the line of the original skin-incision (Step 1). Reflect downwards the flap of bone and superjacent soft parts formed by the preceding steps (Fig. 339). The rectum is isolated, tumor excised, and intestinal wound closed as in Kraske's operation. After attending to hemostasis the wound is loosely packed with iodoform gauze and the sacro-coccygeal bone-flap is partially replaced. The patient is kept on his side for a few weeks to avoid injury to the flap; the wound heals by granulation and the flap gradually assumes its normal position. Schlange was able to exhibit to the Berlin Medical Society a patient on whom he had performed the above operation six weeks previously with a result perfect as regards both comfort and function.

Inguinal Colotomy as a Preliminary to Excision of the Rectum.—Should inguinal colotomy be performed as a preliminary to excision of the rectum? Quénu seems to consider that such is always advisable; other surgeons seem to consider that it is always needless. Probably the truth lies between these extremes.

The disadvantages of a preliminary colotomy are mainly the following:

(*a*) The annoyance of an operation performed some days before the main intervention.

(*b*) The risk and annoyance of an operation performed to close the inguinal anus some weeks after the main intervention.

(*c*) Adhesions of the sigmoid flexure to the abdominal wall at the site of the artificial anus, interfering with the pulling down of the rectum necessary to excise the tumor and approximate the divided ends of the gut.

This is *the real* objection to the operation, but it may be overcome either by exercising care in choosing the part of the colon to be united to the abdominal wall or by making the artificial anus on the *right* side of the abdomen.

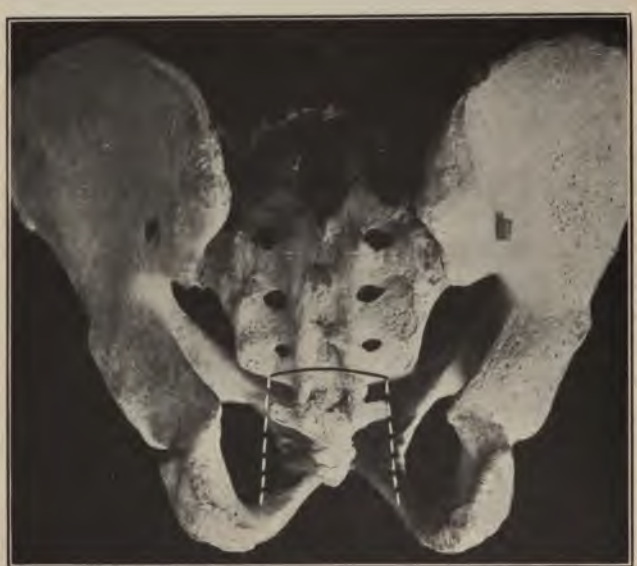


FIG. 339.

The main advantages of preliminary colotomy are as follows:

(*a*) Through the abdominal cavity one can explore the upper limits of an extensive cancer and observe the presence of serious lymphatic extension.

(*b*) One prevents the passage of fæces into the diseased rectum and can thoroughly irrigate it with solutions introduced either

through the anus or through the colotomy wound. During the after-treatment one is not dependent upon opium as a means of keeping the wound free from fæcal contamination. With the aid of a preliminary colotomy it is easy to, at least, approximate cleanliness in an excision of the rectum.

What are the indications for radical operation in rectal cancer?

Whenever cancer of the rectum is diagnosed, it should be removed at once. Too much should be removed rather than too little. This should be the invariable rule except when the patient's local or general condition is such that the operation affords no hope of recovery, in which case palliative treatment, *e. g.*, by colotomy, must be initiated.

A few years ago cancer of the rectum was considered beyond remedy by operation if the upper limits of the tumor could not be reached by the finger passed through the anus. Mere extent of tumor along the gut no longer contraindicates operation. Extension of the tumor through the intestinal walls and involvement of neighboring tissues is a matter of great import. As a general rule, it may be said that when the tumor has become absolutely immobile, the disease is so widespread that operation is worse than useless; that when the immobility is only partial it may possibly be due to simple inflammatory adhesions, and operation may be justifiable, though exceedingly dangerous. Esmarch does not consider involvement of the base of the bladder in the cancerous process a contraindication to operation—he boldly excises the diseased bladder-wall and sutures the defect. Extensive involvement of the pelvic lymphatic glands is a contraindication to operation which can rarely be utilized unless the abdomen is explored. If one practises preliminary colotomy, one has the opportunity to examine the pelvis before fixing the colon to the belly-wall.

Choice of Operation.—In most cases where the tumor is well within reach and its uppermost extension can be easily palpated by the finger introduced through the anus, the operation through the anus or peroneum may be chosen. In such localized and easily surmounted tumors the results are excellent.

Kelsey writes: "The advantages of the sacral incision may be briefly enumerated as follows:

"1. To dissect methodically cancers situated high up, and preserve the sphincters.

"2. To completely remove cancers distinctly circumscribed, but which would be inoperable by the older methods, their upper limit being beyond the reach of the knife.

"3. To preserve, in whole or in part, the external sphincter, even when the rectum is involved low down.

FIG. 340.—(*Monod and Vanverts.*)

"4. To avoid the formation of a cloaca, even when the recto-vaginal septum is invaded by the disease.

"5. To attack recurrent growths while yet limited, and give to the sufferers one more chance of health.

"6. Finally, to render more easy and precise the extirpation of non-malignant strictures."

Combined Abdominal and Perineal Rectectomy.—*Quénu's Method.*—*Step* 1.—Place the patient in Trendelenburg's position. Open the abdomen in the middle line below the umbilicus.

Step 2.—Ligature of both internal iliac arteries. Note the inferior border of the promontory of the sacrum; on each side of this can be felt the pulsation of the internal iliac arteries or of the common iliac if the division has not yet taken place. At this level, $1\frac{1}{4}$ inches (3 cm.) from the middle line and a trifle to the inner side of the pulsating artery, place the middle of a 2-inch incision through the peritoneum alone. By blunt dissection retract the outer lip of the peritoneal wound and with it the ureter. Expose the common and the external iliac arteries.

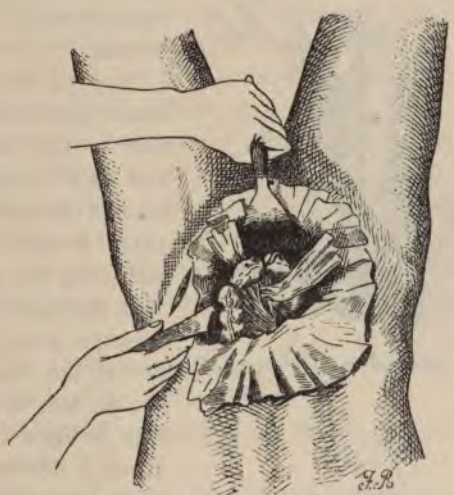


FIG. 341.—(*Monod and Vanverts.*)

A little downwards and inwards expose the internal iliac and ligate it at a point a little more than one-half inch below the bifurcation (Fig. 340). On the left side the ligation is not so easy as on the right, because the origin of the meso-sigmoid hides the vessels. Two methods are possible: (*a*) Preferable when the meso-sigmoid is short. Lay the sigmoid flexure against the iliac fossa; make an incision, symmetrical to that on the right side, so as to get through the meson and expose the parietal peritoneum. Incise the exposed peritoneum, retract the outer lip of the

peritoneal wound, and proceed to the ligation as on the right side. (*b*) If the meso-sigmoid is very long, pull the sigmoid upwards, incise the parietal peritoneum immediately below the origin of the meson, and thus reach the vessels directly. When it is evident that the ligation of the left internal iliac will be difficult, it is simpler to put this step off until after the sigmoid has been divided and the field of operation has been made easier of access. While the iliac vessels are exposed, examine this region for enlarged lymphatic glands. Close the wounds made in the peritoneum over the arteries.

FIG. 342.—(*Monod and Vanverts.*)

Step 3.—At a point free from blood-vessels tear a hole in the meso-sigmoid and pass a large strip of gauze through it (Fig. 341). Protect the abdominal cavity with gauze pads. With the fingers empty the contents from that portion of the sigmoid opposite the tear in the meson. Doubly ligate the gut and divide it between the ligatures, preferably with the thermocautery. Cover the divided ends of gut with gauze and rubber caps held in place by a thread or a rubber band. This to prevent soiling. Working downwards from the tear in the meso-sigmoid, divide that structure between forceps or ligatures and push aside temporarily the lower segment of gut.

Step 4.—Make an incision, in the left iliac region, through the parietes (Fig. 342) and pull the divided end of the upper segment of gut through this. Fix the gut in position by a few sutures. A permanent artificial anus is thus provided.

Step 5.—Pull the lower segment of gut (viz., that to be removed) forwards and upwards against the pubis. Divide the meso-rectum and ligate the hemorrhoidal vessels. When the posterior connections of the rectum have been separated, proceed to incise the recto-vesical *cul-de-sac* if this is possible of access. Lay the whole lower segment of gut, well covered with gauze pads, in the deepest part of the pelvic fossa. Completely close the abdominal wound, after as far as possible diminishing the peritoneal laceration by means of sutures applied to the remnants of the meso-rectum.

Step 6.—Place the patient in the lithotomy position and complete the operation by removing the loosened rectum and its protecting pads of gauze by the perineal route, if necessary excising the coccyx and portions of the sacrum. Provide for perineal drainage and close the perineal wound with sutures.

Step 7.—According to circumstances, either leave the portion of gut which has been fixed in the left iliac region untouched for two or three days, or open it immediately so as to empty the bowels. In the formation of the artificial anus the use of Paul's tube (page 292) will aid in preventing soiling of the dressings.*

R. F. Weir's Operation.—This operation is suitable in cases of cancer situated high up in the rectum.

Step 1.—Open the abdomen in the middle line or through the left rectus muscle.

Step 2.—Free the rectum from its connections to a point near the tip of the coccyx posteriorly and to the edge of the prostate anteriorly.

Step 3.—Divide the gut between two ligatures above the tumor (Fig. 343).

Step 4.—By means of forceps passed up through the anus seize the upper end of the lower segment of gut and pull it out through the anus, thus inverting the gut. Cut away the tumor.

*The above description has been taken, practically completely, from Monod and Vanverts' "Traité de Technique Operatoire."

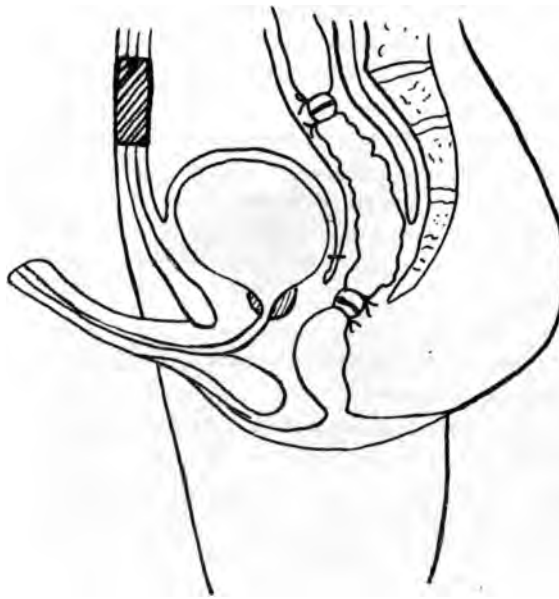


FIG. 343.—(*Weir, "Jour. Am. Med. Assoc."*)

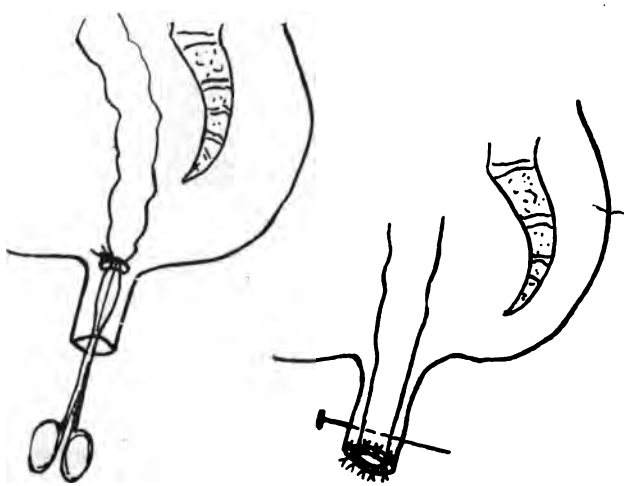


Fig. 344. Fig. 345.

FIGS. 344 AND 345.—(*Weir, "Jour. Am. Med. Assoc."*)

Step 5.—Pull the distal end of the proximal segment through the inverted lower segment. The serous surfaces of the two segments lie in apposition. Unite the two segments by means of Maunsell's method of suturing (page 284) (Fig. 344).

Step 6.—Reduce the prolapsed gut. Suture the pelvic peritoneum, divided when freeing the rectum from its connections (Fig. 345). This suture shuts off the general peritoneal cavity

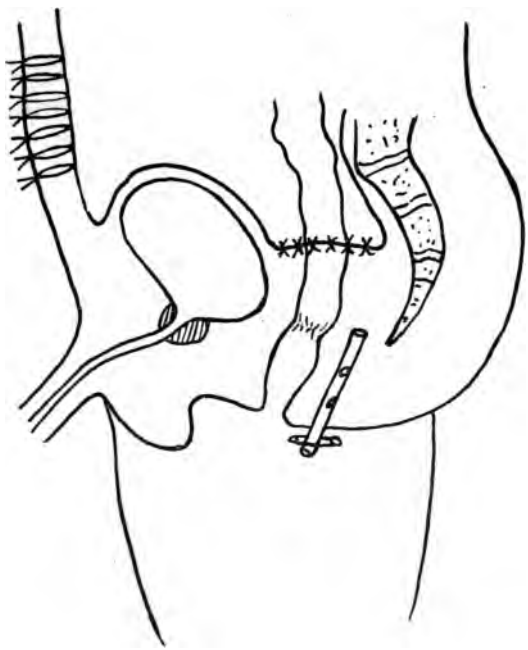


FIG. 346.—(*Weir, "Jour. Am. Med. Assoc."*)

from the deep portion of the pelvis. Drain the lower portion of the pelvis through an incision made behind the anus (Fig. 346).

Maunsell and Trendelenburg have performed a very similar operation, but drain the deep pelvis with gauze brought out through the abdominal wound.

Rotter ("Handbuch der praktischen Chirurgie") writes:

"The tendency of the French to make a permanent iliac anus in every case is not approved in Germany. Whenever practicable, we endeavor to preserve the sphincter ani, and consequently continence. This, as a rule, can be attained. The danger of infection is very slight, as the gut is only opened at the end of the operation. If union of the divided ends of the gut is impossible owing to the shortness of the upper segment, we prefer to make a sacral rather than an iliac anus."

German surgeons, as a rule, make use of an abdomino-dorsal instead of an abdomino-perineal operation. By the sacral (dorsal) route they expose and free the rectum as far as conditions permit, and then, if they meet with difficulties, open the abdomen, mobilize the gut to the necessary extent, close the abdominal wound, and pull the gut (rectum and, if necessary, sigmoid) out of the sacral wound, when the neoplasm is excised and the divided ends of gut united by circular enterorrhaphy or by the invagination method.

CHAPTER VI.

THE PANCREAS.

The pancreas is so deeply hidden behind the abdominal cavity that it has been much neglected even by the pathological anatomists. The fact that, when it is injured, other organs are always notably injured at the same time, and the patient is evidently in a critical condition, has led operators to neglect direct investi-

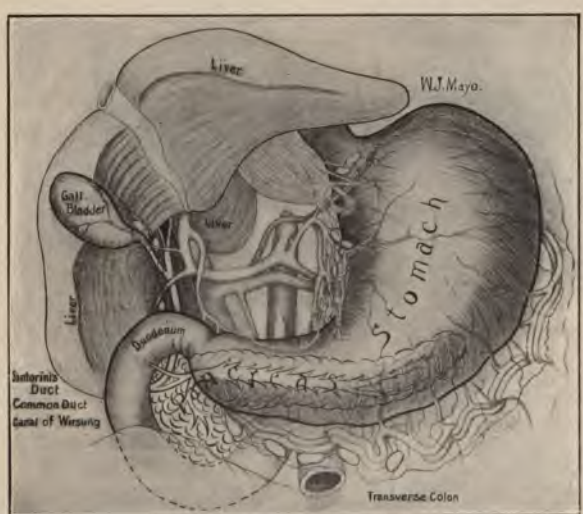


FIG. 347.—ANATOMICAL RELATIONS OF THE PANCREAS.—(*Mayo.*)

gation or inspection of the gland. Until very recently the only pancreatic lesions attacked by surgery were cysts. To-day, thanks to the labors of many pathologists, internists, and surgeons, more knowledge has been attained and this "hermit kingdom" is being opened up to surgical therapy.

The pancreas reaches from the duodenum to the spleen and discharges its secretions through the canal of Wirsung into the duodenum. Before entering the gut the canal of Wirsung unites with the common bile-duct to form the diverticulum or ampulla of Vater (Fig. 347). Besides the main duct or canal of Wirsung, there is a secondary duct (duct of Santorini), which arises from the

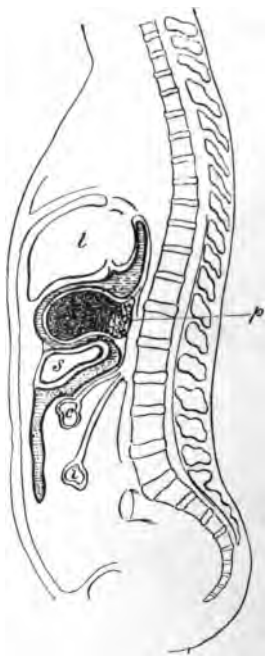


FIG. 348.
Tumor of pancreas. Stomach and colon both below it.—(*Robson and Moynihan.*)

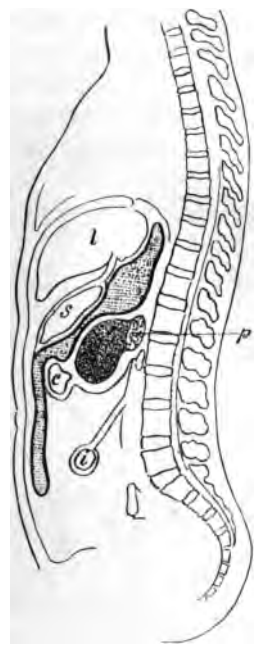


FIG. 349.
Tumor of pancreas. Stomach and colon both in front of it.—(*Robson and Moynihan.*)

main duct near the head of the gland and discharges into the duodenum at a slightly higher level. The tail or left extremity of the pancreas lies in front of the left kidney and the suprarenal capsule. The most important vascular relations of the pancreas are the splenic artery on its upper surface, the splenic vein on its posterior surface, while at its head is the pancreatico-duodenal

artery, which forms an arch with the superior mesenteric. The pancreas lies behind the posterior parietal peritoneum and in front of the lower portion of its head is the transverse mesocolon; in front of its body is the stomach.

There are several routes by which the pancreas may be reached: (1) Through the gastro-hepatic omentum above the stomach; (2) through the gastro-colic omentum below the stomach; (3) through the transverse mesocolon back of colon and the stomach; (4) by retracting inwards the second part of the duodenum; (5) through the stomach; (6) from the loin behind the peritoneum.

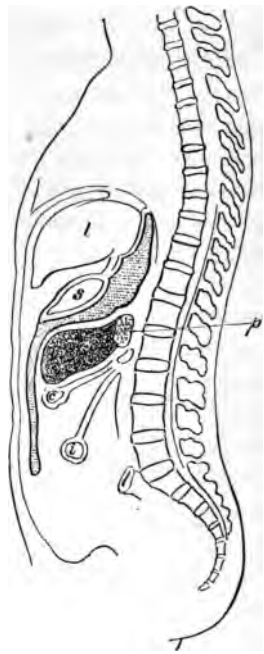


FIG. 350.
Tumor of pancreas pushing forwards between the posterior layer of the great omentum and the transverse mesocolon. Stomach above, colon beneath, it.—(*Robson and Moynihan.*)

Operation upon a pancreatic cyst forms a good type on which to base a description of surgical interference.

Step 1.—Open the abdomen in or near the middle line above the umbilicus. If the cyst makes a prominent swelling, it may be well to make the incision, vertically, over its most prominent part. Explore the abdomen, note the presence and extent of adhesions, and where the cyst presents. This may be above, behind, or below the stomach, behind or below the transverse colon (Figs. 348, 349, 350, 351, 352).

Step 2.—(A) The cyst presents or is most prominent above or behind the stomach. Make a vertical tear through the gastro-hepatic omentum; this at once exposes the cyst. Endeavor to explore the relations of the cyst, but do not persist in the exploration if great difficulties arise, lest harm result. In a few instances it may be found possible to excise the disease; most commonly marsupialization is the operation of choice.

(B) The cyst presents between the stomach and transverse colon, behind the colon, or behind the stomach. Make a vertical tear through the great omentum and expose, explore, and treat the cyst.

(C) The cyst presents behind or below the transverse colon. Pull the transverse colon and great omentum out through the

FIG. 351.
Tumor of pancreas. Stomach in front, colon below, it.—(*Robson and Moynihan.*)

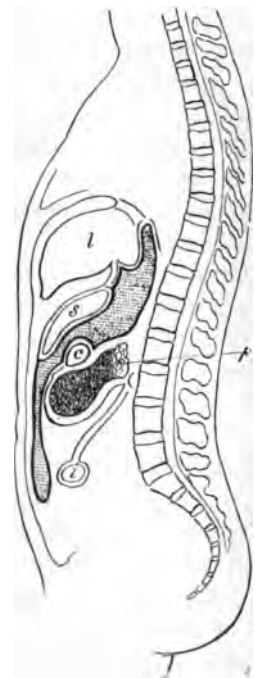


FIG. 352.
Tumor of pancreas. Stomach and colon both above it.—(*Robson and Moynihan.*)

belly wound and turn them upwards exactly as is done in posterior gastro-enterostomy. In an avascular area of the transverse mesocolon make an appropriate tear and expose, explore, and treat the cyst. Do not injure the mid-colic artery or any of its main branches.

(D) Körte has reached the head of the pancreas by forcing his way along the side of the duodenum after incising its peritoneal covering. This is very similar to Vautrin's method of reaching the lowest segments of the common bile-duct.

(E) *Transgastric route:* Hagen ("Archiv f. klin. Chir.," lxii, 157) reports a case in which complications compelled him to attack the cyst after incision of both the anterior and posterior gastric walls. The stomach was inseparably and indistinguishably adherent to the cyst. If was impossible to reach the cyst and bring a portion of its wall to the parietes by any ordinary means. Hagen made a two-inch incision through the anterior wall of the stomach and a small one through the posterior wall. There was no line of demarcation between the stomach and cyst-walls. After evacuation of the contents the cyst was explored with the finger. It was possible with care to bring a small area of cyst-wall to the parietes, to the left of the great curvature, below the ribs, behind the left gastro-epiploic artery and vein. Before the selected portion of cyst-wall could be united to the parietes it was necessary to resect the cartilages of the ninth and tenth ribs on the left side; this permitted the soft belly-wall to sink inwards and meet the cyst-wall as it was elevated. Closure of the gastric wound by suture and marsupialization of the cyst completed the operation. Recovery. Hagen considered the possibility of lumbar drainage, but in his case it was out of the question.

(F) *Lumbar route:* Remember that the tail of the pancreas lies in front of the left renal vessels, hence any operation by which the hilus of the kidney is exposed will also give access to the left extremity of the pancreas. Exposure of the kidney through the loin is so fully discussed elsewhere, and exposure of the tail of the pancreas is so similar, that further description is unnecessary here.

In the course of transperitoneal operations it is often advisable or necessary to provide lumbar drainage. To effect this, explore the cyst with the finger; guided by the finger and carefully avoiding all important structures such as the renal vessels,

etc., push a closed forceps through the posterior parietes below the twelfth rib and immediately external to the erector spinæ muscle. Incise the skin and deep fascia at the point made prominent by the forceps. Make the opening large enough to avoid compression of the tube or gauze used for drainage. With the forceps pull a drain (gauze or tube) into position. It is well, when preparing a patient for any operation on the upper half of the belly, in which posterior drainage may be required, to follow Park's advice, and clean the lumbar region as well as the abdomen; thus valuable time may be saved in the course of the operation. Deaver's plate (Fig. 353), although drawn

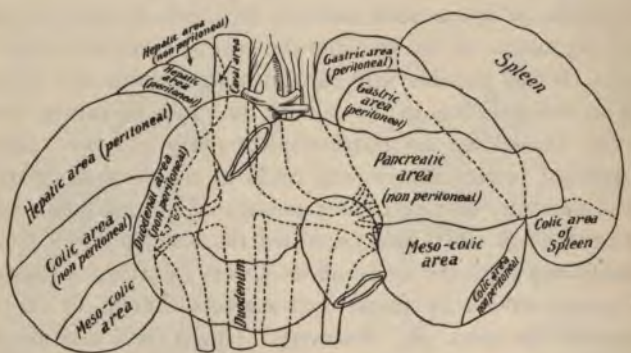


FIG. 353.—(*Deaver.*)

to illustrate the relations of the kidney, illustrates the important anatomical relations of the pancreas, especially with regard to exposure through the lumbar route. Only the head and tail of the pancreas are accessible by this posterior route, the tail being more easily reached than the head. Peters was successful in exposing and draining a hydatid cyst of the tail of the pancreas through the left lumbar route.

Step 3.—Treatment of the cyst. Dangers: The dangers inseparable from operations on the pancreas are less pronounced in cystic than in other diseases or lesions. It will be convenient, however, at this time, to discuss the dangers of pancreatic opera-

tions in general; v. Mikulicz gives a good résumé of these in his paper on "The Surgery of Trauma and Inflammatory Processes in the Pancreas" ("Transactions of the Congress of American Surgeons and Physicians," 1903).

1. Hemorrhage. The pancreas is exceedingly vascular; its tissues are fragile, and hence simple ligature is often entirely ineffective. Sutures involving a mass of healthy or uninjured tissue, as well as the bleeding area, are necessary in spite of the dangers from necrosis incident to the use of mass ligatures. Secondary hemorrhage is common. It is wise, when possible, to prepare the patient, prior to operation, by the exhibition of large doses of chloride of calcium, as recommended by Mayo Robson in cases of jaundice.

2. Leakage of pancreatic juice into the parenchyma of the gland and the surrounding peritoneal structures constitutes a greater danger even than bleeding. The juice, even when sterile, does much positive damage; it also diminishes the resisting power of the tissues so that the mildest form of infection, ordinarily harmless, becomes of the gravest significance. Infection is liable to reach the injured area through the pancreatic duct from the duodenum, in the same manner as it passes up the common bile-duct. Fat necrosis and pancreatitis, both chronic and hemorrhagic, may be occasioned by trauma, and hence may result from operation. Peritonitis is very liable to result from pancreatic leakage. This peritonitis may be aseptic and is frequently followed by intestinal paralysis, leading to rapidly developing obstruction, which often so modifies the symptoms as to lead to a serious mistake in diagnosis. (v. Mikulicz.)

3. It has recently been shown that by the time such definite symptoms of pancreatic disease arise as diabetes or severe disturbance of its fat-digesting function, there is, as a rule, already such great destruction of its substance that surgical interference is not admissible. The author operated on one case of very recent pancreatic diabetes in the hope that drainage might relieve the inflammation to which it was believed the disease was due; the patient did not survive more than twenty-four hours. Nash

("Lancet," Nov. 1, 1902) reports a case of pancreatic glycosuria associated with cholelithiasis in a man of sixty years. After removal of a large calculus from the gall-bladder, recovery ensued. The urine four months after operation was free from sugar. In Woolsey's three successful operations for acute pancreatitis only one had glycosuria.

(A) *Excision of the Cyst.*—This operation is suitable only in cases where adhesions are few or where the cyst has become pedunculated. Ransohoff has collected 23 cases of enucleation with 2 deaths. The operation requires no special description, as the surgeon must follow the common principles of surgery after the tumor has been exposed by one of the methods described above. v. Mikulicz lays down the absolute rule that whenever the pancreatic tissue has been exposed, drainage is requisite.

(B) *Marsupialization or Drainage.*—Expose the cyst by any of the methods described. Protect the peritoneal cavity thoroughly with pads. Note the part of the cyst which can be most readily brought into apposition with the abdominal wall. If the site of the primary abdominal incision proves unsuitable, a secondary incision may be made. If the cyst is very tense, empty it, at least in part, by means of the aspirator. Suture the cyst-wall to the parietal peritoneum. Explore the cyst cavity. Especially note if the tumor is a true pancreatic cyst, *i. e.*, one arising in the gland itself; or a false one, *i. e.*, a collection of fluid in the lesser peritoneal cavity due, as a rule, to injury or disease of the pancreas. If necessary, provide drainage by means of lumbar puncture. Provide tubular or gauze drainage of the cyst or a combination of tubular and gauze drainage. If the cyst-wall is of suitable consistency, it is well to fix a "dressed drainage-tube" into it, exactly as is done in the case of the gall-bladder. If the cyst-wall is too thin to be sutured with safety to the parietes, or if it cannot be brought to the abdominal wound, protect the peritoneum with gauze packing around a tube which leads into the cyst. As a whole, the methods of draining pancreatic ducts are identical with those for draining the gall-bladder, but in the case of the former greater danger is to be feared from

the effects of the leakage of fluid into the peritoneum. Having provided for drainage, close the excess of wound in the abdominal wall.

Usually, under the above treatment, the cyst shrinks and becomes obliterated. Occasionally a fistula persists.

Solid tumors of the pancreas are rarely suitable for operation. Ruggi in 1890 and Gade in 1895 successfully removed tumors from the tail of the pancreas; most of the other cases reported promptly died.

Acute Pancreatitis.—The tendency at the present time is to operate very early in this most fatal disease. The operation consists in an exploratory incision above the umbilicus. In doing this, be on the lookout for patches of fat necrosis; these are yellowish-white patches of various sizes situated in the subperitoneal mesenteric and omental fatty tissues. Fat necrosis is always indicative of pancreatic disease.

According to indications found after the abdomen has been opened, the pancreas should be exposed either through the great omentum above the colon, or through the transverse mesocolon. The belly cavity must be thoroughly protected by gauze packing. If abscess is present, the pus is now evacuated, if requisite, incision being made into the pancreas for this purpose (case of Dr. C. B. Porter of Boston, reported by v. Mikulicz, "Trans. Am. Cong. Phys. and Surg.," 1903). Sloughs and gangrenous tissue should be removed and drainage provided. In spite of all care and thoroughness in operating, the disease must continue to prove most fatal.

Subacute Pancreatitis.—The operative treatment of subacute pancreatitis is practically the same as that of pancreatic cysts and requires no special discussion. Mayo drained, with success, one case of this nature through the gall-bladder, as is done in chronic pancreatitis.

Chronic pancreatitis is treated by cholecystostomy or cholecystenterostomy.

Pancreatic Lithiasis.—Stones are formed in the pancreatic as in the biliary duct. Calculi existing near the ampulla of

Vater may be extracted through a duodenal incision, as in the case of gall-stones. As a rule, the removal of pancreatic calculi has been accomplished incidentally during the evacuation of abscesses in subacute pancreatitis. Moynihan was the first to remove a calculus where the diagnosis had been made prior to operation. When a calculus can be felt in the exposed pancreas it is proper to incise the gland, remove the stone, close the pancreatic wound with sutures, and provide for drainage.

Traumata.—Whenever structures around the pancreas are injured one ought to suspect and look for injury to that organ. When in a case of bullet wound the posterior wall of the stomach is penetrated, it is extremely probable that the pancreas is also involved. Remember, experience teaches that a comparatively slight injury to the gland may lead to disastrous results from leakage of the digestive juice. Lacerated fragments of the pancreas must be removed. Wounds in its substance must be sutured with catgut, care being taken not to occlude the duct by the suture. Whether sutures are used or not, drainage must be established, preferably by means of cigarette drains, which may be introduced through the abdominal wound or through a special lumbar wound or by both routes. After the pancreatic lesion has been attended to, it is good practice thoroughly to douche the general peritoneal cavity with hot salt solution in order to get rid of, or at least dilute, any effused pancreatic juice.

CHAPTER VII.

THE SPLEEN.

Surgical Anatomy.—"The spleen is a soft, highly vascular, and easily distensible organ, of a dark, purplish-gray color. It is placed obliquely in the back of the left hypochondrium, between the cardiac end of the stomach and the diaphragm, and in the line of the axilla extends from the eighth to the eleventh rib." Its shape is that of a compressed oval having three surfaces. "Of these, one, the external and posterior, is large and convex, fitting against the commencement of the arch of the diaphragm and looking upwards, backwards, and to the left. A second, the narrowest, is placed vertically, and looks directly inwards, being applied to the outer border of the left kidney; whilst the third surface, which is separated from the last described by a distinct vertical ridge, is larger than it and concave. This surface is applied to the great cul-de-sac of the stomach and is in contact also with the tail of the pancreas and with the extremity of the arch of the colon (splenic flexure). Near the ridge above mentioned there is a vertical fissure in the anterior surface, at the part where the vessels and nerves enter the organ; this part is termed the hilus." (Quain.) The spleen is held in place by means of reduplications of peritoneum. Such are the gastro-splenic, pancreatico-splenic, and phreno-splenic ligaments. Occasionally there is a colo-reno-splenic ligament at the lower extremity of the spleen. (Villar.) The splenic blood-vessels are contained in the gastro-splenic omentum. The splenic artery, after giving off the gastro-epiploica sinistra, breaks up into a number of branches, a few of which—the vasa brevia—turn back to the stomach. The remaining branches enter the spleen at the hilus. The splenic vein, in its origin, corresponds to the artery. It is a large vessel and lies below the artery. In its subsequent course it is situated behind the pancreas.

Splenopexy.—Splenopexy is performed for the cure of "floating spleen." Several methods have been devised to anchor the spleen in the left hypochondrium.

(A) *Rydygier's Method.*—Freely open the belly in the middle line. Locate the spleen. Between the ninth and tenth ribs make a transverse incision through the parietal peritoneum (Fig. 354). Introduce the fingers through this incision and separate the peritoneum, below the incision, from the parietes, and thus form

Fig. 354.

Fig. 355.

FIGS. 354 AND 355.—(*Monod and Vanverts.*)

a pocket whose mouth is directed upwards (A, A, Fig. 355). The pouch is made sufficiently large to receive the lower end of the spleen. If the spleen (B) is placed in this pouch, its weight may enlarge it so that the operation is rendered useless. To prevent this, insert a few catgut sutures through the peritoneum and part of the parietes immediately below the lower limit of the pouch. These will prevent further separation of the peritoneal flap from the parietes. Place the lower end of the spleen in the pouch. Unite the free edge of the peritoneal

flap, forming the pouch, to the gastro-splenic ligament by one or more sutures. If it seems desirable, suture the spleen itself to the peritoneal incision, or form, from the peritoneum above, a flap with its base next the spleen; reflect this flap over the spleen and suture it to the gastro-splenic ligament.

(B) *Bardenheuer's Method.*—Place the patient on his right side. Make an incision in the axillary line, from the tenth rib to the iliac crest. At the level of the tenth rib make an incision at right angles to the first. Divide the soft parts down to the peritoneum. Make an opening through the peritoneum of size sufficient to permit of exploration and of the passage of the spleen through it. Have an assistant, with his hand on the belly-wall, push the spleen towards the wound. Bring the spleen out through the peritoneal wound. With sutures diminish the size of the peritoneal wound and unite it to the splenic pedicle. Pass one stout suture through the lower end of the spleen and tie it around the tenth rib. Close the wound in the soft parts. The spleen now lies with its inferior pole in a retroperitoneal pouch; its pedicle is fixed to the peritoneal wound, and its body is suspended from the tenth rib.

The foregoing operations are so recent that their merits have not been fully tested; probably Bardenheuer's is the safer and easier.

Splenectomy.—The spleen may be removed for the following conditions (Greig Smith):

1. Injury or prolapse.
2. Certain cases of movable spleen.
3. Simple hypertrophy, with or without cirrhosis.
4. Sarcoma or lympho-sarcoma in the early stages.
5. Cysts.
6. Hydatid disease.

In cases of leucocythæmia the spleen ought *never* to be removed.

Jonnesco recommends the following method of operating: The surgeon should stand on the patient's *right* side, because from this side he obtains a better view of the pedicle, the ligation of which is the most important step in the operation.

Step 1.—Make an incision in the linea alba from the ensiform cartilage down to or below the umbilicus.

Step 2.—*Isolation of the spleen.* This step is usually easy, but it may be very difficult or impossible. Adhesions may be so extensive and firm that the spleen may be practically fused to its own bed or the parietes. Extensive and firm adhesions may be a contraindication to continuing the operation. When the adhesions, though intimate, are destructible, the operation may be continued, but in separating them one must, where necessary, injure the abdominal wall or even the diaphragm rather than the spleen itself. All adhesions which may contain blood-vessels must be doubly ligated before division. When the phreno-splenic ligament is vascular, it must be separated into several bands, each of which is doubly tied and divided. To reach and examine this ligament the following manœuvre is essential. The operator, covering the spleen with a gauze pad, pulls it to the right, while an assistant draws the left lip of the wound to the left; this exposes the bed of the spleen and the diaphragmatic vault. Having divided the phreno-splenic ligament, the adhesions of the spleen to its bed are next attacked. Often adhesions to neighboring organs require division. Once the adhesions, both normal and abnormal, have been separated, it is easy to enucleate the organ, beginning with its lower extremity.

Step 3.—*Section of the pedicle.* When delivered from the belly cavity the spleen is turned over to the left so as better to expose the internal surface and its pedicle. Division of the pedicle ought to be accomplished by separating and dividing between two ligatures, *each vessel in turn*, from the lower side upwards. The separation of each vessel is one of the most delicate steps in the operation. One must avoid: (*a*) Too great traction on the pedicle. This is done by an assistant supporting the spleen and preventing its sudden displacement. (*b*) Rupture of a vessel while separating it. To prevent this accident, use the fingers, instead of instruments, for the separation of vessels or groups of vessels (the isolation of single vessels is often impossible). The isolation and ligation of the splenic artery (often as large

as the femoral) and of the vein, which often accompanies it, are rendered specially difficult because of the tail of the pancreas, to which they are often adherent. When this is the case, it is best to throw two strong ligatures around these structures, ligate *en masse*, cut between the ligatures, and then apply individual ligatures.

Step 4.—*Revision of the splenic bed and final hemostasis:* Examine the whole bed from which the spleen has been removed and stop any bleeding. Retract the stomach and intestines to the right and examine the pillar of the diaphragm. Here there is often to be found a bleeding point which may be secured by a few stitches uniting the peritoneum over it.

Step 5.—Close the abdomen. The dressings applied should be compressive and elastic, so as to fill up the void left by the removal of a large spleen.

Contraindications usually given and Jonnesco's opinion thereof:

(*a*) *Cachexia:* This will undoubtedly remain a contraindication, but it is difficult to define the limits of this contraindication. Cases with marked cachexia have been greatly improved by operation.

(*b*) *Adhesions:* The presence of adhesions may constitute a contraindication. When it seems possible to separate the adhesions, the surgeon must consider: (1) The general condition of the patient, as to his powers of enduring a long and laborious operation; (2) the quantity of ascites taken as an index of the alterations present in the organs of the belly; (3) the friability of the splenic tissues; this is a continual menace while adhesions are being separated.

(*c*) *Size and weight of the spleen:* This is no real contraindication. Jonnesco has operated successfully in patients from twelve to sixty-two years, some having enormous hypertrophies.

(*d*) *Leucocythæmia* is always an absolute contraindication.

CHAPTER VIII.

THE SUPRARENAL BODIES.

The suprarenal bodies rest upon the diaphragm opposite the eleventh and twelfth ribs. They are separated by an interval of 2 to 2½ inches. They are situated at the upper and inner border of each kidney, and obtain a rich supply of blood through special arteries from the aorta and through branches of the renal and phrenic arteries. In front of the left suprarenal lies the stomach; to its outer side is the spleen. The right suprarenal "is related in front to both the inferior and posterior surfaces of the right lobe of the liver (impressio suprarenalis); internally to the vena cava, which slightly overlaps it, and its inferior angle is crossed by the first bend of the duodenum. It lies behind the foramen of Winslow." (Woolsey.)

Adrenalectomy.—The surgery of the suprarenal bodies belongs more to the future than the present, but even now enough has been done to demand a short notice here.

The most common cause of Addison's disease is tuberculosis of the suprarenal body, and most of the successful operations have been performed in such cases. Usually operation has been undertaken on a diagnosis of "retro-peritoneal tumor" or of a tumor affecting the upper pole of the kidney, and these errors in diagnosis are liable to be repeated in the future. An early recognition of suprarenal disease is impossible in our present state of knowledge or ignorance.

The suprarenal bodies may be reached through the lumbar region or through the peritoneum. When the former route is chosen, the incision must be extensive, and exactly like that for nephrectomy. In most cases of adrenalectomy, nephrectomy will be part of the operation, for two reasons: (*a*) because the removal of the kidney renders less difficult an atrociously difficult

operation; (*b*) because the kidney is often involved in the disease, especially if that disease is malignant.

Helferich operated through the lumbar route and partially removed a tuberculous suprarenal with complete success (Schede, "Handbuch der praktischen Chir.," iii, 1106). Most operations have been performed by the transperitoneal route. Oestreich diagnosed and Hadra operated upon a pulsating tumor of the suprarenal. When the abdomen was opened in the middle line above the umbilicus, a tumor the size of a hen's egg, of a whitish and yellowish-brown color, was seen through the lesser omentum. This tumor was on and to the left of the aorta, and after excision proved to be a much caseated suprarenal body. The wound was packed and the patient recovered. In a case operated on by Jonas (Schede, *loc. cit.*) the bronze hue so characteristic of Addison's disease faded in ten days and disappeared in three weeks. There is little prospect of much benefit from operation on malignant tumors of the suprarenals.

CHAPTER IX.

OPERATIONS UPON THE LIVER.

OPERATIONS FOR HEPATOPTOSIS, OR MOBILE OR FLOATING LIVER.

Ptosis of the liver may be partial or complete.

Partial ptosis means that a portion of the liver is more or less pushed away or snared off from the rest of the organ as a result of error in dress (tight lacing) or of some disease. Riedel's tongue-shaped lobe, so common in cholelithiasis, is a form of partial ptosis. Occasionally the junction between the aberrant lobe and the rest of the liver is thin, and from irritation, etc., has become sclerosed.

Complete ptosis means that the liver is dislocated *en masse* to a greater or less degree.

(A) **Operations for Partial Hepatoptosis.**—1. *Indirect Operations.*—When the ptosis is in the form of a Riedel lobe and dependent on gall-bladder disease, the latter disease must be treated according to the methods advised in the chapter on Biliary Surgery. Excellent results are thus obtained.

2. *Excision.*—The mobile lobe may be excised. (See "Hepatectomy.")

3. *Ventro-fixation.*—Open the abdomen over the most prominent part of the tumor. Suture the "floating lobe" to the parietes by several thick catgut sutures. Before tying the sutures scarify the surfaces about to be opposed.

4. *Kehr's Operation.*—Kehr, adopting Rydygier's idea in splenopexy, applies it to the fixation of partial hepatoptosis. Make a horseshoe-shaped incision (concavity upwards) around the lower circumference of the mobile lobe, down to but *not* through the transversalis fascia. At the lowest point in the

wound open the belly by a transverse incision through the transversalis fascia and the peritoneum. Separate the transversalis fascia and the peritoneum, together, from the more superficial structures of the parietes over an area corresponding to the horseshoe-shaped incision. At the upper end of this loosened area make an incision through the fascia and peritoneum parallel to the lower transverse incision. A pocket of fascia and peritoneum is thus formed into which the "floating lobe" or its lower margin may be tucked and secured. Close the wound with sutures.

(B) **Operations for Complete Hepatoptosis.**—(I) *Step* 1.—*Exposure of organ:* This may be accomplished by a vertical incision either in the middle line or along the external border of the right rectus muscle, or by a cut parallel to the costal arch. The vertical incisions are the better, and may be supplemented by a transverse cut if such appears necessary.

Step 2.—*Return the liver to its normal position.* If the organ has become adherent in its faulty location, the adhesions must be separated, unless, of course, they are so extensive that the danger involved in their separation would be out of proportion to the good to be attained by a successful hepatopexy. An assistant supports the liver in its improved position while the surgeon carries out the next step.

Step 3.—*Fixation of the liver by sutures:* Pass coarse catgut or silk sutures through the parenchyma of the anterior edge of the liver, each suture taking a deep hold of the organ, and then make the sutures penetrate between the cartilages of the adjacent ribs. During this procedure the pleura has been injured, but no harm has resulted. The sutures must be thick to avoid cutting the friable organ. In actual practice the number of sutures has varied from two to eight; the more numerous they are, the more is the strain divided and the liability to cut lessened. The hepatic and parietal surfaces which are to be opposed should be scarified before the sutures are tied. Care must be taken, when the sutures are being tied, to avoid cutting the liver substance with the threads. Some surgeons apply a few sutures

between the liver and the upper end of the abdominal wound. Lucas Championnière modifies the operation by passing some of the threads through the suspensory ligament.

If it is impossible to reduce the liver, it may be fixed by suture wherever possible so as to give relief from distressing symptoms.

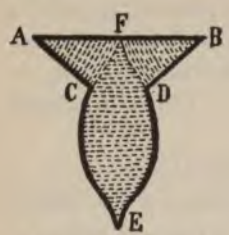


FIG. 356.—(*Monod and Vanverts.*)

(II) *Depage's Operation* (*Hepatopexy and Laparectomy*).—Depage considers laxity of the abdominal walls a great factor in the production of hepatoptosis and directs his attention specially towards removal of this condition.

Step 1.—Make the horizontal incision A B (Fig. 356) from the tip of the eleventh rib on one side to the tip of the eleventh rib on the other side. From the point A make an incision A C, downwards and inwards to meet an imaginary line passing horizontally through the umbilicus. The length of the cut A C is equal to one-half the cut A B. From the point B make the incision B D in the same way as A C was made. From the points C and D make curved incisions downwards to near the pubis. The convexity of the curves is outwards. These cuts meet at the point E. Remove all the skin enclosed by the above incisions. Dilatation of the belly has caused the linea alba to become very wide. "Remove the linea alba, including the peritoneum, from the anterior or internal border of one rectus muscle to the internal borders of the other rectus muscle. Make traction upon the umbilical ligament of the liver and the inferior extremity of the falciform ligament, and, pulling them into the upper angle of the wound, shorten and anchor them there by sutures."

FIG. 357.—(*Monod and Vanverts.*)

Step 2.—Suture the abdominal wound with extreme care.

Depage sutures in planes as follows: (*a*) The peritoneum alone; (*b*) the peritoneum and muscular planes together; (*c*) the muscular plane alone; (*d*) the aponeurotic and muscular planes together; (*e*) the aponeurosis alone; (*f*) the skin and subcutaneous tissue together; (*g*) the skin alone. In suturing, the edge of the wound A C is united to the edge A F; the edge B D to B F, and the edge C E to the edge D E. The resultant scar is **T**-shaped (Fig. 357).

HEPATECTOMY.

As it is self-evident that the liver can never be removed *in toto*, it is useless to prefix the word partial to the title of this section.

The experiments of Ponfick, repeated and supported by other observers, have proved that much liver tissue can be removed without specific injury (three-fourths was removed in animals), and that new liver tissue is formed to take the place of that removed. The great impediment to hepatic surgery has been the fear of hemorrhage. Many methods have been adopted to overcome this real danger. A few of the methods will be described.

I. Exposure of the Tumor.—The abdomen is opened over the tumor by a cut made in any direction which may be convenient or by a combination of cuts. The incision must be large enough to give very free access to the field of operation. The tumor is now examined as to diagnosis and location. It is assumed that the diagnosis is such that radical operation is permissible. If the tumor involves most of the right lobe of the liver, the operation must be at once abandoned, so also if the hilus is much involved. Tumors on the posterior and superior parts of the liver are inaccessible. Tumors of the left lobe and of the anterior margin of the organ may be brought forwards by division of parts of the hepatic ligaments; this permits of partial dislocation of the whole organ. Some surgeons have excised the lower ribs (subperiosteally) and have thus been enabled to retract the diaphragm upwards. When the patient is lying on his back with the posterior hepatic region supported on a sand-

bag, it is extraordinary how much of the liver may be brought out through the Mayo-Robson incision (page 381) without any resection of ribs. It is difficult to believe that enough benefit can be attained by rib resection to warrant the extra trauma and risk.

II. Removal of the Tumor.—When peritoneum exists over the tumor and is free from disease, it should be divided and reflected from the surface of the tumor. If the tumor is non-malignant and appears to be fairly well encapsulated, it may often be shelled out of its hepatic bed with but little hemorrhage. When the tumor is very small and situated at the liver margin, it may be removed by a **V**-shaped incision made with knife, scissors, or thermocautery. While the cut is being made an assistant compressing the neighboring liver controls bleeding temporarily. When the tumor is attached to the liver by a distinct pedicle, the pedicle may be surrounded by an elastic ligature and the tumor removed, or the removal may be accomplished without the aid of the elastic constrictor. In all the above instances bleeding is temporarily controlled while the tumor is being removed. When the tumor is non-encapsulated, non-pedunculated, or involves much of the liver substance, one requires to proceed step by step, stopping bleeding as one goes.

Methods of Hemostasis.—I. During the operation:

(*a*) *Temporary elastic ligature:* A rubber tube thrown around a pedicle permits the surgeon to remove the tumor at his leisure and subsequently take other means to stop the bleeding permanently. When there is no pedicle, it has been advised to pierce the whole thickness of the liver behind the tumor with a cannula, place a *double* elastic ligature through the instrument, and tie the ends of the ligature on each side of the tumor so as to act as a tourniquet.

(*b*) Auvray recommends applying to the liver around the portion to be removed a series of interlocked ligatures of thick silk or catgut. To apply the ligatures use a blunt pedicle needle with a very long curve. Each individual ligature, after being crossed with its fellow to the right and left, is slowly and steadily tied with such firmness that the liver parenchyma is cut, but the

vessels remain undivided in the loop. When the whole series of ligatures are tied, the tumor is removed with cautery, knife, or scissors. It is of importance while transfixing the liver with the needle to use little force, and when any obstacle to the passage of the instrument is encountered, to manipulate the needle from side to side and so gently guide it past the obstruction. Such obstructions are usually large vessels, and any force used might injure them. The points of transfixion should be about one centimeter (⅜ inch) apart. Auvray's researches have been very thorough and successful. The method he advises certainly appeals to one's common sense.

Freeman has used with success, for the same purpose and in similar manner, narrow strips of gauze. He found much difficulty in removing the gauze because the knots sank into the liver substance, so he now recommends that the ends of gauze be fastened with forceps or catgut instead of being knotted. ("Trans. Am. Surg. Assoc.," 1904.)

(*c*) *Thermocautery:* Many surgeons use the thermocautery instead of the knife when dividing liver. While the cautery does not control bleeding from the larger vessels, it certainly does control oozing. The cautery ought always to be ready when hepatic incisions are made, since it may be found useful, at least as an aid to other methods.

(*d*) *Ligature:* The ligation of hepatic vessels is often difficult, their walls being thin and delicate. Frequently direct ligation of the vessels is impossible. When this is the case, one may, with a curved needle, pass a suture around the vessel, and on gently tying it the bleeding ceases. To this suture-ligature the Germans give the name "Umstechung."

The above are the principal means of hemostasis used during the operation.

II. The methods of securing hemostasis after the operation are practically the same as the methods of treating the stump.

(A) *Intraperitoneal.*—The liver wound, having been closed by suture or ligature, or charred by the thermocautery, is allowed to drop back in the belly. If peritoneal flaps were dissected back from over the tumor, they are replaced and sutured together.

The parietal wound is closed. Very rarely will this be a safe practice. The dangers of bleeding are great, and before the surgeon is able to recognize that hemorrhage is actually taking place, much blood may be lost.

(B) *Extraperitoneal.*—The tumor is delivered through the abdominal wall. The pedicle is compressed by an elastic ligature. The tumor is cut away. The stump is fixed to the abdominal wall by sutures or by pedicle pins. The elastic ligature is left *in situ.* The dangers of this method are, first, that the sutures or pins fixing the liver to the abdominal wall are very liable to cut through the friable liver substance; and, second, that the risks of infection through the stump are very real. Some surgeons have performed the operation in two stages. At the first sitting the liver is attached to the belly-wall. Only after adhesions have formed is the tumor removed. When applicable, this may be a good method.

(C) The pedicle is treated as in A, but the liver wound is walled off from the rest of the peritoneal cavity by means of gauze packs and a tampon of gauze is pressed against the wound itself. The ends of the pieces of gauze used for pack and tampon are brought out through the abdominal wound.

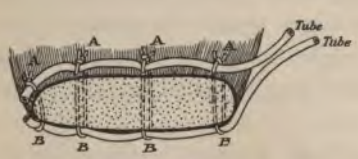


FIG. 358.

Undoubtedly the best way to treat the stump where possible is by a combination of suture and packing. The surface of the pack facing the abdominal cavity should be covered by rubber tissue. The ends of the catgut sutures applied to the liver should be left long and tied over the pack so as to keep the latter in place. (See "Cholecystectomy.")

To exert hemostatic pressure upon the liver and to prevent the cutting of the parenchyma by sutures one rubber tube may be laid on the upper surface of the liver, another on the lower surface. Thick catgut sutures (A, B, Fig. 358) penetrating the liver are fastened to the tubes. The ends of the tubes are brought

out of the wound and are to be removed when they have served their purpose. Instead of rubber tubes, plates of decalcified bone and of various materials have been employed.

Kocher has applied his large stomach clamp to the liver with force, crushing through the parenchyma and excising the portion of liver distal to the clamp. He leaves the clamp *in situ* for forty-eight hours.

ABSCESS OF THE LIVER.

Aspiration.—Aspiration as a method of treatment for liver abscess is not to be recommended. It has its sphere of usefulness as a means of diagnosis, but its use is not without danger.

The skin is cleaned over the most prominent or most tender part of the swelling, usually the ninth or tenth interspace vertically below the angle of the scapula, and the sterilized aspirating needle is inserted in various directions until pus is found. Greig Smith remarks that "the movements of the needle, following the movements of the liver (if it moves with respiration), must not be checked, as thereby the liver tissue may be torn and permit escape of pus into the peritoneum."

Hepatotomy.—(A) *Abdominal Route.*—The object of operation is to expose the enlarged liver; to examine it; to excise into and evacuate the contained pus without soiling the general peritoneal cavity. An incision four to five inches in length is made over the most prominent part of the swelling. This incision is usually longitudinal. The belly is opened and the liver examined. If the liver is found adherent to the parietes opposite the wound these adhesions ought to be preserved, as the avoidance of peritoneal contamination is rendered easier by their presence. When a sufficiency of adhesions is not present, the portion of liver about to be attacked is carefully isolated from the peritoneum by pads of gauze. Unless the exact location of the abscess is very evident, an aspirating needle is passed into the liver until pus is found. The needle being held in place, a knife or the blade of a cautery is inserted into the abscess, guided by being kept in contact with

the needle. The needle is withdrawn. The forefinger is pushed into the abscess along the side of the knife, which is now taken out. The abscess cavity is explored digitally and any signs of a second abscess noted. If such exists, it may be opened from the first cavity by the finger or a closed hemostat being pushed into it. The abscess cavity is now carefully douched with hot water, a rubber drainage-tube is inserted to its deepest part, and the rest of the cavity loosely filled with mildly iodoformized gauze. The pads of gauze which have protected the peritoneal cavity are removed and the neighboring peritoneum is mopped clean and dry. Smith recommends that the whole length of the incision in the liver be sutured to the abdominal wound. This may be done with very coarse catgut or silk sutures. Coarse sutures are necessary, as fine ones would cut through the liver substance. Any of the abdominal wound unoccupied by attached liver is closed by sutures. Abundant absorbent dressings are applied and the patient put to bed.

According to the amount of discharge the wound will require dressing at more or less frequent intervals. The outer dressings, *i. e.*, those down to the drainage-tube, will probably require to be changed in a few hours. Unless demanded by the condition of the patient, the packing of iodoform gauze filling the abscess cavity ought not to be changed before twenty-four or forty-eight hours after operation. When the packing is withdrawn, if necessary, the abscess cavity may be gently douched with hot water. This is best accomplished by attaching a soft-rubber catheter (sterilized) to the tube of an irrigator and passing it into the deepest part of the cavity. Thorough and gentle lavage is thus insured. The irrigator ought not to be elevated much more than two feet. After washing, the cavity is once more loosely filled with mildly iodoformized gauze and the dressings applied. In all such cases iodoform is better than plain gauze, but the iodoform ought to be in small quantity, as absorption is liable to be great in such an organ as the liver.

(B) *Transpleural or Thoracic Route.*—When the abscess is situated far back on the dorsum of the liver, evacuation by the ab-

dominal route is inapplicable. By the time that a hepatic abscess has become large enough to be diagnosed and its position ascertained, there is almost always adhesive pleuritis present; the liver is adherent to the diaphragm, and the diaphragmatic pleura to the parietal, so that a safe route exists to the pus via the obliterated portion of pleural cavity.

The Operation.—Place the patient on his sound side. Demonstrate the presence and location of the pus by the aspirating needle introduced through the ninth or tenth intercostal space vertically below the angle of the scapula. Make an incision about three or four inches in length along the rib immediately below the aspirating needle. Excise about two inches of this rib, subperiosteally. As a rule, the site of the excised rib is below the pleura or this portion of pleura is obliterated. If the pleural cavity is opened by accident or design, it must be at once protected (*a*) by the insertion of a few catgut stitches to close the cavity, (*b*) by applying a pack of gauze. This gauze pack may well be held in place by a few stitches of fine plain catgut. By the time it is safe to remove the gauze the catgut will have been absorbed. The diaphragm lies exposed; seize it with forceps and incise it. This exposes the liver, usually adherent to the diaphragm. The aspirating needle still *in situ* forms a guide to the abscess, which must be evacuated as described in the preceding paragraphs.

Choice of Operation.—Many surgeons consider the thoracic route the preferable. When sufficient adhesions are present, it undoubtedly is exceedingly safe, but, on the whole, the abdominal route is the better. More cases of liver abscess can be reached through the abdomen than through the chest, and, while a satisfactory examination of the liver for secondary and complicating disease is possible, the dreaded increased danger from possible soiling of the peritoneum can be practically completely averted by suitable packing with gauze.

SUBPHRENIC ABSCESS.

Subphrenic abscess is commonly a sequel of perforative gastric ulcer, of appendicitis, and of hepatic abscess; its treatment may be merely an extension of the treatment of the primary disease. The treatment, of course, consists in evacuating the pus and in securing efficient drainage. The pus is reached in practically the same manner as is that in a hepatic abscess, and the methods require no special description. Counteropenings for drainage may be necessary.

CHAPTER X.

OPERATIONS ON THE BILIARY PASSAGES.

Operations on the gall-bladder and bile-ducts are most commonly required because of the presence of gall-stones or of infective processes.

Preparation of the Patient.—The preparation for the operation is identical with that for almost any other abdominal operation, but when chronic jaundice is present, calcium chloride should be administered by the mouth in thirty-grain (gr. xxx) doses for two or three days prior to the operation, and in sixty grain (gr. lx) doses per rectum for a few days thereafter (Mayo Robson). This rather heroic exhibition of calcium chloride is the great preventive of the hemorrhage which is so often fatal after operations on the jaundiced. All cases of obstruction due to stone in the common duct, in which purpuric spots are present in the skin, die from hemorrhage if operated upon. Some of these cases when treated with calcium chloride improve sufficiently for operation to become justifiable.

Position of the Patient.—Place the patient on his back and support the region of the liver on a firm sand-bag 18 inches long, 6 inches wide, and $3\frac{1}{2}$ inches deep. This opens the costal angle and makes the intestines gravitate from the field of operation; it also pushes "the spine forwards, and with it the liver and bile-ducts, so that the common and hepatic ducts are brought several inches nearer to the surface." (Robson.)

Methods of Exposure of the Gall-bladder and Ducts.—Very many incisions have been advocated and used, but only a few will be described.

Method A.—Mayo Robson's incision: Make a vertical incision over the middle of the right rectus muscle. Separate the fibres of the muscle with the fingers or the handle of a scalpel. Divide

the posterior sheath of the rectus and the peritoneum together. This incision is two to three inches in length. When it is necessary to explore the hepatic, common, or deeper portion of the cystic ducts, continue the original incision *upwards* as far as possible in the space between the ensiform cartilage and the right costal margin following the costal margin (Fig. 359). The incision is similar to the upper part of Bevan's incision. It freely exposes the upper surface of the liver. Lift the lower border of the liver in bulk (if necessary, drawing the organ downwards from under cover of the ribs), thus bringing the whole of the gall-bladder and the cystic and common ducts quite close to the surface. As the gall-bladder is usually strong enough, let the assistant take hold of it with his fingers or forceps and by gentle traction keep the parts well exposed, while at the same time he protects and retracts, with a sponge in his left hand, the left side of the wound and the viscera which would otherwise obstruct the view. "It will now be observed that instead of the gall-bladder and cystic duct making a considerable angle with the common duct, an almost straight passage is found from the fundus of the gall-bladder to the entrance of the bile-duct into the duodenum, and if adhesions have been thoroughly separated, the surgeon has immediately under his eye the whole length of the ducts with the head of the pancreas and the duodenum." (Robson, "Brit. Med. Jour.," January 24, 1903.)

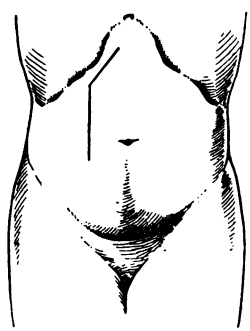


FIG. 359.

Method B.—Bevan's incision: Bevan criticizes the vertical incision in the right semilunar line as being insufficient, and when long, objectionable because of nerve destruction; the T-shaped incision is difficult to close and is liable to lead to hernia; median incision does not give free access to the gall-bladder. He advocates the following method ("Annals of Surgery," xxx,

17): Make a vertical incision along the outer border of the right rectus muscle or between its outer fibres. This suffices for exploration or the completion of a simple cystostomy. If it seems necessary to expose or work on the ducts, enlarge the incision by continuing its upper end obliquely upwards and inwards, its lower end obliquely downwards and outwards. This gives excellent exposure and does little injury to nerves, but it necessitates transverse division of the abdominal muscles.

Method C.—Kehr's incision: Kehr's incision is very similar to Bevan's and possesses similar advantages and disadvantages. From the ensiform process make a cut in the middle line downwards for about 1½ inches; then divide the right rectus obliquely and continue the cut downwards in the semilunar line.

Method D.—Kocher's oblique incision: Make an incision four inches in length parallel to and about two inches below the right rib margin. This incision divides the outer fibres of the rectus muscle and portions of both the internal and external oblique. Branches of the intercostal nerves run across the incision towards the rectus, and these must be retracted downwards or upwards and preserved uninjured. Kocher's incision gives very free access to the biliary region, but necessitates an undue amount of muscle injury.

EXAMINATION OR EXPLORATION OF THE GALL-BLADDER AND BILE-DUCT.

When the abdomen is opened, the gall-bladder is usually easily recognized, and it is easy to palpate this viscus, to follow the cystic duct downwards, and, by passing the finger through the foramen of Winslow, to palpate at least the supra-duodenal portion of the common duct. Often the gall-bladder is hidden in a mass of adherent omentum or other viscera, or it may be much shrunken as well. Under these circumstances, beginning at the liver margin, separate the adhesions. Use the liver as a guide to the site of the gall-bladder. Many of the adhesions may be separated by the fingers, but many must be cut between liga-

tures. The separation of adhesions must be accomplished with much circumspection, as nature occasionally herself performs the operation of cholecystenterostomy, and when this is the case, the surgeon is liable to penetrate the junction between the gall-bladder and the duct. When this accident occurs, the hole in the gut must at once be closed by a double line of sutures. When the gall-bladder is much shrunken, the search for it makes a severe call on the patience of the surgeon. When the gall-bladder is distended or not shrunken, it is easy to pull it up into the wound. Before breaking down adhesions around the biliary passages be careful to protect thoroughly the peritoneal cavity by means of suitable pads or sponges. When freeing the gall-bladder and the ducts from surrounding adhesions, one is liable at any moment to open into some collection of infective material, and dangers from this source must be guarded against. As was hinted when describing Robson's incision, it is of first-rate importance to free the bile-ducts from surrounding adhesions; if this is not done, the exploration becomes a sham. The guide to the common duct is the gall-bladder and cystic duct.

OPERATIONS ON THE GALL-BLADDER AND DUCTS.

Ideal Cholecystotomy.—This operation consists in opening the gall-bladder, removing any stones which it may contain, and closing the wound by two layers of sutures exactly as one would close a wound in the small intestine. Bernays has advocated this procedure and called it ideal. Vautrin carried out a similar operation, but sutured the closed viscus to the upper part of the abdominal incision (cholecystopexy). Union of the gall-bladder to the upper part of the wound has the advantage that, the fundus being fixed in an elevated position, natural drainage of the viscus is aided. Cholecystotomy is rarely if ever indicated, since to be justifiable it presupposes a practically normal gall-bladder.

Cholecystostomy.—Cholecystostomy is an operation which creates a fistula between the gall-bladder and the parietes. It may be executed in either one or two sittings; usually in one.

Cholecystostomy in Two Sittings.—First sitting: Expose and explore the gall-bladder and ducts. Bring the fundus of the gall-bladder into the upper part of the abdominal wound and suture it to the peritoneum and deepest layer of fascia (transversalis fascia), but *not* to the skin. The sutures ought not to penetrate into the cavity of the viscus, but should merely include a portion of the thickness of its wall (serous and muscular, not mucous, coats). Close the rest of the abdominal wound with sutures. It is well to attach a long silk suture to the exposed portion of the fundus of the gall-bladder, to act as a guide when the viscus is opened at a later date.

Second sitting: In a few days, when adhesions have formed between the gall-bladder and the abdominal wall, make an opening with a knife into the gall-bladder and so establish the fistula.

This operation is eminently safe and was a great aid in establishing the surgery of this region, but to-day the operation in one sitting has become practically as safe and has the incomparable advantage that it permits the finger on the outside of the gall-bladder to assist in the extraction of calculi and in exploration. When the finger cannot enter the abdominal cavity outside the gall-bladder, the extraction of *all* the calculi present becomes a matter of extreme uncertainty.

Cholecystostomy in One Sitting.—Expose and explore the gall-bladder and ducts. Separate all adhesions which impede the work. Thoroughly protect the belly cavity with gauze pads. If the gall-bladder is sufficiently large, pull it up into the abdominal wound. Seize the fundus with two small volsella.

If the organ is tensely filled with fluid, it is usually advised to empty it by means of an aspirator. When the contents are thick, and they usually are so, a small aspirating needle is useless, and a large needle puncture, it seems to the writer, possesses no advantages over a cut. The author has never seen any ill results from immediate incision into the bladder without any preliminary aspiration.

Make a small incision into the viscus. Mop away all fluid which escapes. Enlarge the opening. Remove with the scoop (Fig. 360) any calculi which may be present in the bladder or

adjacent portion of cystic duct. A finger outside the gall-bladder greatly aids. Often stones lying in the cystic and rarely the common ducts may be coaxed by the finger (outside the bladder) up into the bladder and so removed. Too much time must not be expended in trying to coax such stones into the bladder, as other and surer means of extracting them are available. Once more explore the interior of the gall-bladder with the finger. Suture the opening in the gall-bladder to the parietal peritoneum and transversalis fascia in the upper part of the abdominal wound. Gently cleanse the interior of the bladder with gauze; temporarily pack the cavity with gauze. Remove the protective pads from the abdomen and close the free portion of the abdominal wound. Remove the temporary pack from the gall-bladder and introduce into it a rubber tube (a No. 15 F. soft catheter is excellent). Apply abundant dressings. When exploring the gall-bladder after it has been opened, much information may be obtained by palpating with a finger of one hand inside the viscus and the fingers of the other hand outside it, but inside the belly. Occasionally one finds the gall-bladder *apparently* divided into two cavities, both containing calculi. The septa between such cavities require division before the stones can be removed. In suturing the gall-bladder to the parietes J. E. Summers does not sew the edge of the wound in the viscus to the abdominal wound, but passes his sutures through its serous and muscular tunics, in the Lembert fashion, some distance away from the wound, and with these unites the bladder to the parietes. He next surrounds the wound in the bladder by a purse-string suture involving the whole thickness of the bladder-wall. (Any visible or oozing branches of the cystic artery must be secured by running this or the preceding suture under them; neglect of this simple precaution has permitted a fatal hemorrhage.) Then he introduces a tube into the bladder,

FIG. 360.

and tightening the purse-string suture, inverts the edges of the wound around the tube (Figs. 361 and 362).

The Mayos attain the same end as follows: Prepare a drainage-tube by surrounding it with a few layers of gauze covered by rubber tissue. The end of the tube should be bevelled or trimmed in the "fish-tail" fashion. Introduce this "dressed tube" a short distance into the gall-bladder. With plain catgut suture the edges of the gall-bladder wound snugly to the tube. Push the tube a little further into the gall-bladder, thus inverting that portion of the gall-bladder around the tube and the original line of suture. With a Lembert suture of catgut attach the surface of the gall-bladder all around the tube, to the tube. Leave the ends of this last suture long, and with a needle attach them to the parietal peritoneum.

FIG. 361.

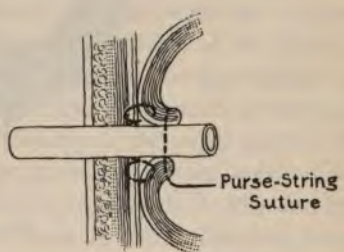


FIG. 362.

The advantages of this excellent procedure are: (*a*) The purse-string suture prevents leakage of bile around the drainage-tube. (*b*) When the tube is withdrawn, the inversion of the bladder wound leaves serous surfaces in contact, there is no prolapse of mucous membrane, and hence closure of the fistula is hastened.

W. D. Jones ("Annals of Surgery," xxvii, 53) pulls the gall-bladder well out of the abdomen and sutures the parietal peritoneum to the viscus at a distance from the opening into it. This line of suture corresponds to the Lembert sutures in Fig. 361.

He next passes a catgut suture through the muscles and fascia of the parietes *into* the gall-bladder, just external to the peritoneal sutures, then with same suture catches the edges of the cystotomy wound and brings the suture out in the reverse direction to that in which it was introduced (Fig. 363).

The result is that when several such sutures are introduced and tightened, they invert the cystotomy wound very satisfactorily.

When the surgeon is not completely satisfied with the cleanliness of the abdomen immediately around the gall-bladder, and

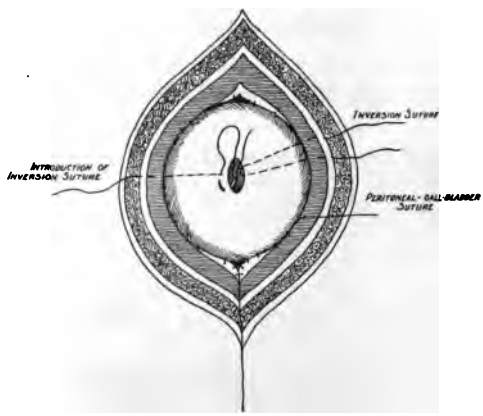


FIG. 363.

does not think it safe to close the abdomen completely, it is easy to pack a strip of gauze immediately below the viscus and bring its end out through a hiatus in the wound. Such gauze packing the author leaves *in situ* for from eight to ten days, and has never seen any reason to regret having left it this long period of time. Adhesions necessarily form around the gauze after a short time, and if it is removed early, the adhesions are liable to be disturbed, while discharges from the biliary fistula are very apt to find their way through the route left by the removal of the gauze. After the lapse of eight or ten days there is no danger in removing the gauze. To prevent the gauze sticking to the stomach, duodenum,

and parietal wound, thus occasioning crippling adhesions, it may be surrounded by rubber tissue (the familiar cigarette drain).

Cholecystectomy.—This operation is called for under several conditions, such as the presence of neoplasms, lithiasis, and inflammation, but the indications necessitating it will be discussed later.

Step 1.—Exposure and exploration of the gall-bladder and ducts.

Step 2.—Aspiration or incision of the gall-bladder is necessary under the following circumstances (Monod and Vanverts): (1) When the viscus is so distended that it is liable to rupture during the necessary manipulations. (2) When external exploration of the common duct leaves doubt as to its permeability and one desires to catheterize the ducts through the bladder. One must remember, however, that the valvular construction of the upper part of the cystic duct does not lend itself to easy catheterization.

In the absence of the above conditions it is better not to open the viscus and thus avoid possible contamination of the wound.

Step 3.—When, as exceptionally happens, the gall-bladder is provided with a "meson," divide this between ligatures or forceps. As a rule, the viscus is applied directly to the under surface of the liver and held there by the peritoneum, and one operates as follows: Incise the peritoneal covering of the gall-bladder and by blunt dissection separate the organ from the liver. Bleeding from the liver may be controlled by suture, by the use of the Paquelin cautery, or by sponge pressure. Isolate and ligate the cystic branches of the hepatic artery; ligate and divide the cystic duct. If it is desired to drain the biliary passages, only one ligature or clamp may be applied between the gall-bladder and the point of section of the duct; if complete closure of the passage is sought, then the duct should be divided between two ligatures. Riedel under the latter circumstances closes the abdominal wound without drainage, but most surgeons agree with Kehr that it is safer and better to pack with gauze and so drain. If drainage of the duct is required or desired, leave the stump of the duct open and

suture over it or to it a rubber drainage-tube with a stitch of fine plain catgut. This stitch will be absorbed before it is time to remove the tube, and in the mean time will hold it in place.

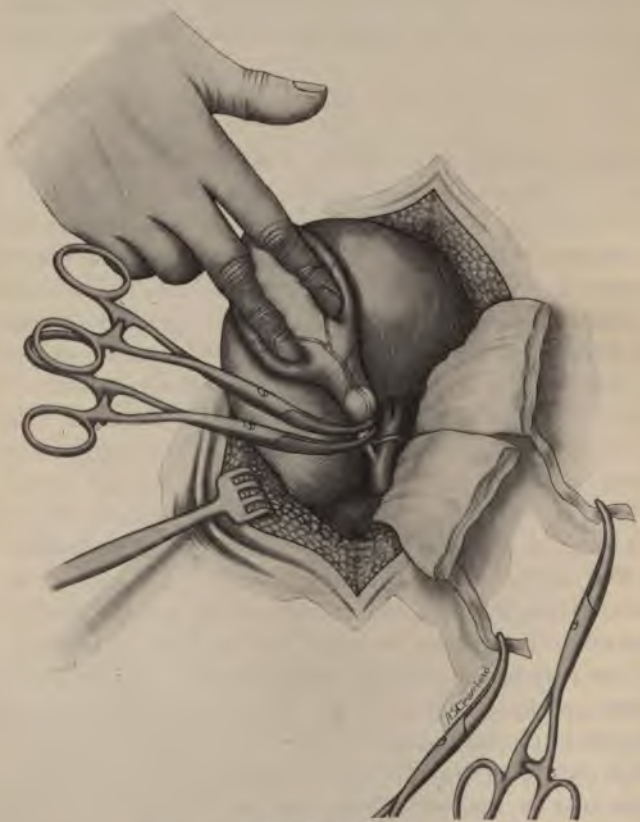


FIG. 364.—(*Mayo.*)

Undoubtedly cholecystectomy is best accomplished from below upwards—*i. e.*, beginning by dividing the duct. There are two principal reasons for this: (*a*) The dissection is easier; (*b*) the cystic artery (generally two branches) is ligated at the same time

as the duct and thus hemorrhage is completely controlled at the earliest possible moment.

The Operation.—Step 1.—Open the belly by Robson's incision. If possible, pull the liver to a large extent out of the wound, the gall-bladder being used as a tractor (Fig. 364).

Step 2.—If the stone is present in the cystic duct, apply a curved forceps to the duct below the stone.

Step 3.—Divide the duct, and incidentally the cystic artery, between the forceps and the stone. The stone acts as a plug to the part of the duct left attached to the gall-bladder. If no such plug is present, apply a second forceps and cut between the two forceps (Fig. 364).

Step 4.—Dissect free from its attachments a short segment of the duct still attached to the gall-bladder. This is to give space for the next step. Do not yet attempt to remove the bladder—it is of too great value as a tractor.

Step 5.—Apply a ligature, preferably of stout catgut, around the stump of the cystic duct (*i. e.* the stump continuous with the common duct). To prevent slipping, this ligature must be applied with a needle, penetrating the tissues. Retain control of the stump by catching it with a hemostat. Remove the original forceps. If bleeding occurs,—it is sometimes free enough to alarm the inexperienced,—stanch it by the insertion of a few more stitches, with the same needle and ligature which surrounds the duct. *Hemostasis must be absolute.* Leave the ends of the ligature long.

Step 6.—Grasp the lower end of the duct, still attached to the gall-bladder, and pull it towards the surface (Fig. 365); as this is done, by blunt and sharp dissection free the gall-bladder from the liver, working from below upwards. As a rule, bleeding is practically *nil;* if it is free, it may be stopped by the sutures applied in the next step.

Step 7.—The gall-bladder having been removed, a raw surface is left on the liver; this surface is bordered by flaps of peritoneum which originally bound the gall-bladder to the liver. Suture these flaps together by a few fine catgut sutures. If necessary, these

sutures may bite into the liver and assist in hemostasis. Leave the ends of these interrupted sutures long (Fig. 365).

Step 8.—Make a roll of gauze (mildly iodoformized) about 1¼ inches wide and ½ inch thick and 4 or 5 inches long. Over one side of this place a layer of rubber tissue. Around one end of this roll tie a ligature of fine plain catgut. Tie this fine catgut to the ligature surrounding the stump of the duct, so that the roll of gauze is held snugly against the stump and covers it. Lay

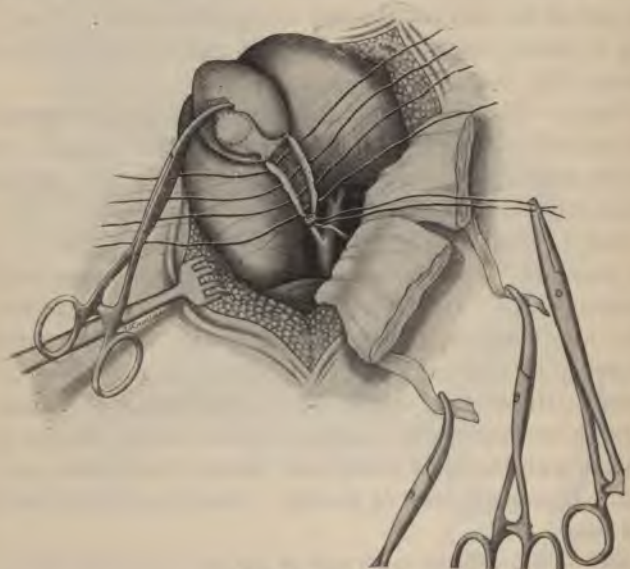


FIG. 365.—(*Mayo.*)

the roll of gauze (with the rubber tissue next the abdomen, the gauze next the liver) along the site from which the gall-bladder was excised. Tie the sutures inserted during Step 7 over the roll of gauze. Bring the end of the gauze out of the abdominal wound. Close the abdominal wound.

When the duct end of the gall-bladder is much adherent and anatomy is rendered very obscure, the above operation or any ordinary cystectomy is out of place. The Mayos' method of

removing the most of the gall-bladder and all the mucosa of the remnant of that viscus and of the cystic duct is much easier than cystectomy, as efficacious, and infinitely safer.

The Mayos' Operation.—In cases where it is desirable to obliterate the gall-bladder ultimately, but in the mean time to use it as a means of draining the biliary passages, it is wise to operate as follows: Expose, explore, and open the viscus as in cholecystostomy. Amputate the fundus and most of the gall-bladder. Excise the mucosa from the remainder of the gall-bladder and adjacent part of the cystic duct, beginning with the duct mucosa. Pass a "dressed drainage-tube"—*i. e.*, one covered by gauze and rubber tissue—into the duct and suture the remnant of the gall-bladder, with catgut, tightly to the tube. When the drain is removed, the gall-bladder becomes a fibrous cord.

Cholecystenterostomy.—When the common duct is irreparably occluded, *e. g.*, by malignant disease, or when it is desirable to drain the ducts in chronic pancreatitis, the formation of a fistula between the gall-bladder and the gut permits the escape of bile. This operation is cholecystenterostomy. When possible, it is best to unite the gall-bladder to the duodenum, but under stress of circumstances that portion of the intestine (even the colon) which is most readily brought up against the gall-bladder is the best portion to use. The operation itself is practically identical with that of entero-enterostomy (intestinal anastomosis) and requires no special description. It may be accomplished by the method of suture, by McGraw's elastic suture, or by the Murphy button. Probably the oldest patient ever submitted to this operation was a woman eighty years of age, in whom the author successfully used the Murphy button. Before the operation of choledochotomy was as safe as it is to-day, cholecystenterostomy was much more frequently resorted to than at present; it averted the evils from obstruction of the common duct by stones, but it did not rid the patient of the obstruction itself or of the late effects of the irritation from the obstructing calculus.

When the gall-bladder is anastomosed to a segment of small intestine, it has been suggested that an anastomosis between the

afferent and efferent segments of the gut would prevent all possibility of intestinal contents gaining access to the gall-bladder. This precaution seems, to the author, superfluous, as it would not prevent the passage of the ever-present infection from the intestine into the gall-bladder, even if it did keep the gross contents of the intestine from entrance into that viscus. The increased danger of the extra operation seems out of proportion to the benefit to be obtained.

Cysticotomy—Incision into the Cystic Duct.—When calculi are present in the cystic duct, it is often possible to extract them through the gall-bladder. If this is not easy to accomplish, one should not waste much time in such endeavors, but should carefully locate the stones, incise the duct longitudinally over them, and extract them. The wound in the duct may be closed by sutures. The sutures, if of silk or hemp, must not penetrate the mucosa lest they form the nuclei of more calculi. Catgut sutures are excellent and have not this disadvantage. Many surgeons insert but do not tie the sutures before the stones are removed. The suturing is not so difficult as might be imagined, because from disease the ducts are dilated and their walls thickened. It is important to remember that not much time should be devoted to attempts at suturing (the writer has seen death result from such waste of time), since really quite as good results are obtained by drainage of the unsutured passages. The Mayos' suggestion of suturing (with plain catgut) a rubber drain to the open duct and surrounding this with a gauze pack is a most excellent practice, and is eminently safe. On the whole, the inexperienced operator is advised to avoid attempts at suturing the ducts; the Robsons of our profession require no advice, and are marvelously deft with the needle.

Choledochotomy—Incision into the Common Bile-duct.—The common bile-duct may be considered as consisting of two parts: one, supraduodenal, stretching from the junction of the cystic and hepatic ducts to the union of the first and second segments of the duodenum; the other part, retroduodenal, stretching the remainder of the distance to the ampulla of Vater.

The supraduodenal portion of the choledochus is about ¾ to one inch in length and occupies the right margin of the gastro-hepatic omentum. To the left and behind the duct lies the portal vein—further to the left is the hepatic artery. When the duct is dilated by disease, the portal vein may lie in front of it. The dangers from this source have been grossly exaggerated. In operations the portal vein and hepatic artery are rarely seen. The line for safe incision is along the anterior and right side of the duct. The foramen of Winslow is the guide to the duct. A finger passed into the foramen and hooked forwards inevitably brings the duct forwards also. Unfortunately, the foramen of Winslow is sometimes hidden or obliterated by adhesions. Several lymphatic glands exist in the gastro-hepatic omentum, and when enlarged may lead to error. The retroduodenal portion of the choledochus runs for a distance of about 2 inches along the postero-internal border of the second part of the duodenum. The duct for about 1¼ inches before it reaches the ampulla of Vater lies on or in the pancreas. It is evident that the retroduodenal portion of the duct covered by intestine and pancreas is out of reach of palpation by ordinary means. To add to the difficulties, several lymphatic glands, prone to enlargement, exist along this tract and render a positive diagnosis as to the presence or absence of stone impossible without further exposure. Vautrin ("Revue de Chirurgie," June, 1896) has made an extremely exhaustive and important study on the anatomy and surgery of the retroduodenal choledochus, and the following is based on his writings:

Exposure of the Retroduodenal Choledochus (Vautrin's Operation).—Make traction on the second or descending portion of the duodenum. This makes prominent the junction of the intestine and the gastro-hepatic omentum. Beginning at this prominent point, incise the peritoneum parallel to the convexity of the duodenal angle, and prolong the incision along the external border of the second segment of the duodenum, so as to free it from its external serous attachments. This soon exposes that portion of the duct which lies in a groove on the anterior sur-

face of the pancreas. Lower down the duct is embedded in the pancreas and the exposure is more difficult, as various lobules of the gland lying between the duct and the intestine are closely adherent to the muscular coats of the latter. Blunt dissection alone no longer avails; the scissors must be employed and portions of pancreatic tissue must be sacrificed rather than intestinal wall. One and one-fourth inches of the duct may be exposed as above. A further exposure may be made, but to do this the thermocautery ought to be employed because of the numerous veins present. By the above measures the duct can be exposed to a point about ⅜ inch from the ampulla of Vater.

Without previous knowledge of Vautrin's researches Cooper, of San Francisco, came to almost identical conclusions from his studies on the cadaver ("Annals of Surgery," vol. ii, 1903). Abbé also describes a similar method. These operations seem better suited to the dissecting- than the operating-room.

When the finger, passed through the foramen of Winslow, palpates stones in the upper portion of the common duct and the stones cannot *easily* be coaxed back into the gall-bladder for removal—how should they be treated? In the earlier days of the surgery of this region several plans were devised, and under exceptional circumstances might, even to-day, be practised.

1. The stones can be crushed *in situ* between the blades of forceps protected by rubber tubing. This treatment is, of course, liable to injure the duct-walls, and in spite of careful cleansing of the duct through the gall-bladder is certain to leave detritus which may or may not be passed *per vias naturales*.

2. Needles may be passed through the duct-walls and into the stones so as to facilitate their fragmentation. The same objections apply here as to the cholelithotrity by forceps.

3. The stones may be left *in situ*, and, the cystic duct and gall-bladder being free, the operation of cholecystenterostomy may be performed. This overcomes the dangers of biliary obstruction, but does not obviate the dangers inherent to the pres-

ence of retained duct stones, viz., irritation leading to inflammation and malignant disease.

To-day the operation of choice is choledochotomy, or incision into the duct directly over the stone. The portion of the duct affected, exposed as described, is grasped or steadied by the fingers, and an incision is made along it, over the stone, of size sufficient to permit of the easy extraction of the calculus. If it is desired to close the duct wound with sutures, such should be introduced but not tightened before the stone is removed. The stitches, if of silk, include the serous and muscular coats of the duct, but not the mucous. Comparatively few surgeons use sutures, preferring to rely on drainage until such time as closure of the duct takes place naturally. The late Dr. Davis, of Alabama, was responsible for this advance. Having opened the duct and removed the calculi present at the site of incision, pass a probe downwards to the duodenum to insure the patency of the duct below, and upwards into the hepatic duct to explore for any calculi there present. This is the advice usually given, but it is, in fact, impossible by means of the probe positively to exclude the presence of stones; only by palpation with the finger inside the duct can positive knowledge be attained. Kehr strongly recommends that a rubber drain be passed up into the hepatic duct so as to provide exact drainage. Most surgeons pass a rubber drain down to the duct, fix it there with a stitch of plain catgut, surround it with a pack of gauze covered by rubber tissue, and close the external wound except where the drain and pack emerge.

Even if the wound in the duct be sutured, drainage is essential. When the gall-bladder has been opened, it may be treated in various ways: (*a*) It may be excised—cholecystectomy. (*b*) The opening in it may be sutured to the parietes—cholecystostomy. (*c*) It may be drained in the same fashion as the common duct is drained.

The Mayo brothers have systematized the operation of choledochotomy in the following manner:

Step 1.—Open the belly by the Robson incision. Separate

adhesions and explore the gall-bladder and ducts. If the gall-bladder is distended, remove part or all of its fluid contents by the trocar and cannula or by incision. The gall-bladder in case of common-duct stone is commonly much shrunken.

Step 2.—Pull part of the liver out of the wound and towards the right. This exposes the ducts and brings them within reach.

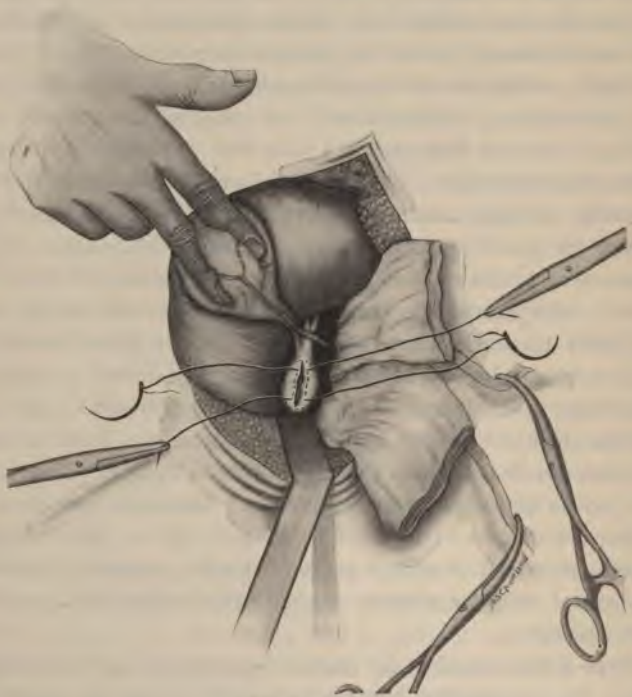


FIG. 366.—(*Mayo.*)

Protect the belly cavity with gauze packs. With the fingers palpate the stone in the duct, and steady it so that it can act to the duct the part of a ball thrust into a stocking that is being darned. (Elliot.) Introduce, *longitudinally,* two fine plain gut sutures into the duct (Fig. 366). These penetrate the whole thickness of the duct-wall, if such is necessary to get a firm hold. Using

the sutures as tractors, make an incision into the duct over the stone. Extract the stone. Explore the duct with the finger in it. The finger passed up the duct and pulled out again (slightly crooked when being pulled out) acts as the piston of a pump and sucks down any small stones which may be in the upper part of the common or in the hepatic ducts. In the large majority of cases the finger can and must be passed up to the division of the hepatic duct and down to the papilla; this can be much simplified by exerting counterpressure on the duodenum and pancreas. Ducts not large enough to admit the finger are usually thin-

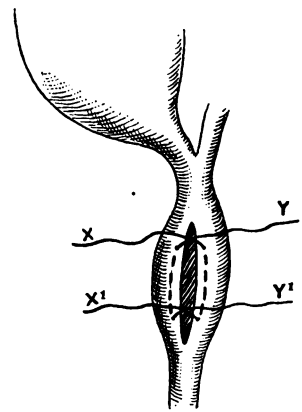


FIG. 367.

walled, not much adherent, and hence palpable from the outside. It is only in difficult cases, *i. e.*, where many adhesions are present and the duct-walls are thickened, that finger exploration inside the duct becomes absolutely necessary. In all cases, when it is possible, this method of exploration should be used. Diverticula hide stones from the probe or scoop, as the nature of the calculi lets them give no feeling of "grit" when touched by metal; only the finger can recognize them.

Step 3.—Treatment of the wound in the duct.

(A) If it is possible to do a cholecystostomy, and the cystic duct is sufficiently patent to permit of biliary drainage, the wound

in the duct may be treated as follows: Cross the one end of suture X with that of suture Y (Fig. 367), and the end of suture X^1 with that of suture Y^1, but do *not* tie them. Place the strip of gauze G (Fig. 368) longitudinally over the wound in the duct and over the crossed sutures. Tie the sutures around the gauze strip, the free side of which is covered by a layer of rubber tissue. This closes the wound and fixes the gauze over it, so that should bile escape it cannot wash away the gauze, and an efficient drain is provided. Bring the end of the gauze out through the abdominal wound. Establish a cholecystostomy. Close the excess of abdominal wound.

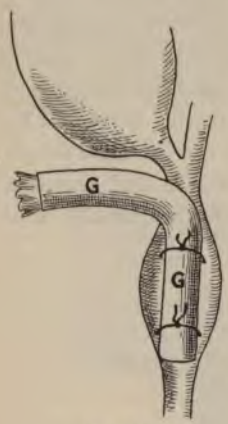


FIG. 368.

(B) If owing to the small size or the diseased condition of the gall-bladder a cholecystostomy is impossible or improper, proceed as follows: Prepare a $\frac{1}{4}$ inch tubular drain wrapped with gauze to within a distance of $\frac{1}{3}$ inch of its end. Introduce the bared end of the tube *into* the common duct; the covering of gauze prevents its going in too far. Thread one end of the suture X–X^1 on a needle, pass it through the tube and tie it to the other end of the same suture. Do the same with suture Y–Y^1. Bring the end of the drain out of the wound and close the excess of abdominal wound (Fig. 369). The end of the tube introduced into the duct should be bevelled or cut in the "fish-tail" fashion. A small gauze

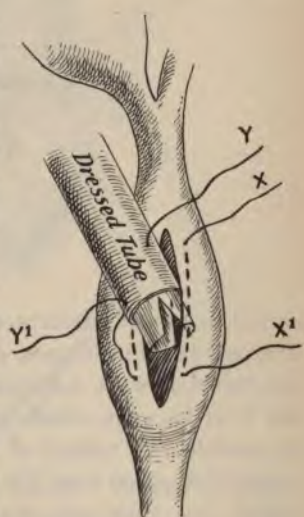


FIG. 369.

pack around the above and tied to the suture Y–Y¹ or X–X¹ is an added safety.

When the obstructing calculus exists very low down in the common duct, one may reach it by the transduodenal route. McBurney ("Annals of Surgery," Oct., 1893) was the first to perform this operation of *duodeno-choledochotomy*. Kocher is a supporter of the method. Mr. Mayo Robson thus describes the procedure: "The termination of the common duct, including the duodenum, should be grasped between the finger and thumb of the left hand and the anterior wall of the gut cut through, thus exposing the interior of the posterior wall of the intestine with the termination of the common duct running in it. Either the duct can be laid open from the papilla, or the stone may be cut down on, through the posterior wall of the duodenum. Bile flows freely as soon as the obstruction is removed, and it must be mopped away as it flows, since it always contains pyogenic microbes and is therefore infective. As a rule, there will be no trouble with bleeding and no sutures need be placed in the posterior wall of the duodenum. The incision through which the duodenum has been opened should be sutured by a continuous catgut suture for the mucous membrane and a continuous silk suture for the peritoneum. No drainage is required. For calculi situated in the lower third of the common duct, especially if impacted in the diverticulum of Vater, the operation is decidedly preferable to the ordinary choledochotomy, as not only is it easier, but an incision of the narrow orifice of the bile-duct in the duodenum leaves a patent opening, which will allow any other concretions that may have escaped observation to pass without difficulty." ("Dis. Gall-bladder and Bile-ducts," 1901, p. 269.)

Hepato-cholangio-enterostomy.—This operation consists in effecting an anastomosis between the gut and the smaller hepatic ducts. It is indicated in those cases in which there is present permanent obstruction of the common and main hepatic ducts or of the common and cystic ducts. Under the above circumstances a cholecystenterostomy would be useless, and a cholangiostomy (*i. e.*, a union of the opened small bile-ducts to the skin)

as practised by Kocher and Langenbuch is objectionable, as it establishes a permanent biliary fistula. Hepato-cholangio-enterostomy was suggested by Baudouin and Langenbuch, but first practised by Hans Kehr. ("Centralblatt f. Chir.," 1904, No. 7.)

The Operation.—Step 1.—Exposure of the gall-bladder region, preferably by Mayo Robson's incision. If necessary, excise the gall-bladder.

Step 2.—From a convenient part of the lower margin of the liver excise a strip of liver tissue about two and one-half inches long by about one inch wide. With the thermocautery stop the hemorrhage and at the same time burn a hole in the liver of such a depth that several moderate-sized bile-ducts are opened.

Step 3.—Choose a segment of gut, preferably duodenum, which can be brought up to the hepatic wound without tension. In this gut make an opening 2½ inches long, and suture it to the margins of the liver wound. In Kehr's case only a few sutures cut loose while being tied, and he was able to close the belly without packing the wound. In most cases one imagines that packing with iodoform gauze, or at least the use of one or more cigarette drains, would be of much value. In the case operated upon recovery ensued and the liver tissue seemed to tolerate the necessary direct contact with intestinal contents.

INDICATIONS FOR AND CHOICE OF OPERATION.

It is undoubtedly true that in at least one-half of all cases of gall-stone disease in which diagnosis has been made, an apparent cure may result from medicinal treatment. Scientifically such a "cure" is generally merely apparent, as the calculi remain *in situ*, but are at rest and give rise to no evident trouble. The patient considers himself well, but he is always exposed to relapse, and the continued presence of the stones is to-day believed to be conducive to malignant disease. Some surgeons believe that every case of gall-stone disease ought to be submitted to early operation. Winiwarter was the first to promulgate this dictum and Riedel takes much the same ground. W. J. Mayo says that

the successful passage of a calculus *per vias naturales* is not a contraindication but a positive indication for operation, as there are always more calculi to follow, and the next ones may become impacted in the common duct, thus necessitating a grave instead of a safe operation. Few modern surgeons advise much loss of time before operation is decided on. In the writer's experience there have been a number of cases where the symptoms were apparently trifling, and yet exploration showed advanced disease. There is great difficulty and danger in operating upon many of the old cases; adhesions and contractions alter the anatomy most confusingly, and all conceivable difficulties arise. Early operation, before the common duct is involved, is easy, and on the whole very safe.

Mr. Robson ("Diseases of Gall-bladder and Bile-ducts," ed. 1901) gives the following indications for the performance of cholecystostomy: "(1) In all cases where the gall-bladder is sufficiently large to permit of drainage, after gall-stones have been removed from the gall-bladder or ducts. (2) In cases where there are gall-stones in the ducts, but the patient is too ill to bear a prolonged operation, the gall-stones being deliberately left for treatment by some solvent solution. (3) In empyema of the gall-bladder, where the viscus is not too much disorganized to be permitted to remain. (4) In certain cases of chronic catarrh of the gall-bladder or bile-ducts. (5) In infective and in suppurative cholangitis. (6) In obstruction of the ducts due to hydatid disease. (7) In dropsy of the gall-bladder. (8) In idiopathic rupture, or laceration or gunshot injury of the gall-bladder or ducts. (9) In cases of choledochotomy, in order to avoid tension in the sutured duct. (10) In certain cases of obstructive jaundice dependent on malignant tumor which is occluding the ducts; but in these cases the increased danger must be borne in mind. (11) In some cases of phlegmonous cholecystitis or gangrene, where the patient is too ill to bear cholecystectomy." To these may be added a twelfth indication, viz., obstruction of the ducts from chronic pancreatitis.

The same author's indications for cholecystectomy are as

follows: (1) In wounds of the gall-bladder where suture is impracticable. (2) In phlegmonous cholecystitis and when there is gangrene of the viscus. (3) In multiple or perforating ulcers. (4) In chronic cholecystitis from gall-stones, where the gall-bladder is shrunken and too small to drain safely, and where the common duct is free from obstruction. (5) In mucous fistula due to stricture of the cystic duct. (6) In hydrops of the gall-bladder due to stricture of the cystic duct; as also in certain cases where the gall-bladder is very much dilated. (7) In certain cases of empyema where the walls of the gall-bladder are very seriously damaged. (8) In cancer of the gall-bladder.

"It is contraindicated in all cases of non-patency of the common duct, and it should not be resorted to under the idea that it will prevent the formation of gall-stones, as calculi may form in the bile-ducts, within the liver, or below it."

Roswell Park goes further than most surgeons, and advocates the excision of all diseased gall-bladders on the same principle that leads to the removal of the vermiform appendix when diseased. It is certainly true that all experienced surgeons are becoming more and more radical and are extending the indications for cholecystectomy at the expense of those for cholecystostomy.

The question is often asked, Are gall-stones liable to form again after they have been removed by any of the above operations? The experience of Kehr, Robson, the Mayos, Riedel, and others, an experience amounting to several thousands of cases, teaches that if the calculi have been all removed there is no recurrence. In the hands of experienced operators apparent recurrences crop up, but these are cases of stones overlooked in the original operation. The younger practitioners must remember that operation is not directed merely against the gall-stones themselves, but against the infective processes which give rise to them and against the complications which they occasion. The author remembers well one case in which a complete cure attended the purely medicinal treatment of gall-stone disease, but the patient succumbed to the remote results of the lithiasis, viz., an extensive adhesive peritonitis causing obstruction of the first

portion of the duodenum. Operated upon early, this case would have been easily cured; a late and compulsory operation was fatal.

The indications for cholecystenterostomy have been sufficiently described in earlier paragraphs.

OPERATION FOR ECHINOCOCCIC CYSTS OF THE ABDOMEN.

Echinococcic cysts are composed of a structureless true capsule or wall on the inner surface of which there develop the young heads of the parasites. The cavity of the cyst is filled with thin fluid in which lie numerous subsidiary or daughter cysts. The whole cyst is surrounded by a firm connective-tissue capsule developed from the liver itself. The cysts may be single or multiple, usually the former.

Out of 18 cysts operated on by Mabit the site of disease was: right lobe liver, 8; left lobe, 3; spleen, 2; omentum, 3; mesentery, 2. The liver being the organ usually affected, the operations here described will have special reference to it.

Several methods of operating on echinococcic cysts have been recommended, but most of them have been discarded in favor of more radical measures. Aspiration is ineffectual and dangerous. Injection of antiseptics—*e. g.*, bichloride of mercury or formalin solution—is dangerous and indefinite. The best method of treatment is enucleation.

According to the site of the disease access is gained to it by one of two routes:

(A) **Abdominal Route.**—When the disease can be reached by this route, and it usually can, it is the preferable one. Open the abdomen by a vertical or oblique incision over the most prominent part of the tumor. Explore the liver, etc., to make sure of the diagnosis, to ascertain whether the disease is single or multiple and to satisfy one's self as to anatomical relations. With gauze packs thoroughly isolate the field of operation from the peritoneal cavity. Protect the edges of the abdominal wound with gauze. The firm false capsule of the cyst will usually show prominently

on the surface of the liver. Seize the false capsule with a stitch or a volsellum. With a trocar and cannula empty the cyst of its fluid contents, thus rendering its walls flaccid. Pull the cyst-wall as far as possible out through the abdominal wound and incise it freely. With fingers, strips of gauze, and salt solution gently evacuate *all* daughter cysts. If possible, peel the true cyst-wall from the false fibrous capsule, but do not endeavor to excise the latter.

Prepare a rubber tube by surrounding it with a few layers of gauze and cover the gauze with rubber tissue. Introduce this "dressed tube" into the cyst, and with plain catgut suture the opening in the cyst around and to the tube. Cleanse the field of operation and remove the gauze pads from the peritoneal cavity. Suture the cyst-wall, around the drainage-tube, to the parietal peritoneum. Close the excess of abdominal wound.

If secondary cysts are present and lie close to that first opened, they may be penetrated from it. Sometimes several cysts may require to be opened through several abdominal incisions. The advantage of sewing, with catgut, the opening in the cyst around and to the drain is that all leakage into the belly is absolutely avoided. The catgut remains effective until union is so far advanced that there is no danger of the peritoneum becoming soiled.

Some surgeons perform the above operation in two stages. At the first operation they expose the diseased portion of liver, pack the wound, and wait ten days or more for adhesions to form and protect the peritoneum. At the second sitting they open the cyst and treat it as already described. There is practically no greater danger in completing the operation at one sitting than in waiting for adhesions to take place, and if the cysts are multiple, the operation in two stages is entirely unsuitable.

The method of treatment outlined is known as marsupialization; its objectionable features are: long convalescence; the dangers of suppuration, and the persistence of biliary fistulæ. Marsupialization is an eminently safe operation.

Bond suggested that the cyst cavity might be obliterated by means of buried sutures, and the abdomen closed without danger.

Other surgeons, after evacuating all the cyst contents, advise filling the cavity with iodoform emulsion or with saline solution, and closing it completely with sutures. There is too much danger involved in this method to render it advisable. The experience of John O'Conor, Mabit, and others shows that the sutured false capsule of a hydatid cyst is very prone to suppuration, and that Bond's operation, however modified, is exceedingly dangerous. Mabit finds that if *much of the cyst-wall protrudes beyond* the parenchyma of the liver, spleen, or whatever organ it affects, such free cyst-wall may be excised and the remainder, after being thoroughly dried, may be left with safety in the belly cavity. The operation of Mabit is improper unless at least one-third of the cyst-wall is free, and unless the contents are sterile as regards pyogenic organisms.

(B) **Transpleural Route.**—When the disease is situated far back on the dorsum of the liver, presses into the subphrenic region, and cannot be conveniently reached from in front, one gains access to it by the transpleural route.

The Operation.—Excise about three inches of the eighth or ninth rib in the anterior axillary line. Suture, with catgut, the parietal to the diaphragmatic pleura. Of course, in inserting these sutures one aims at uniting the two pleural surfaces alone, *i. e.*, without other tissues, but one never succeeds in so doing. The stitch, if effective, always includes in its loop other tissues than the pleura. Incise the diaphragm and expose the liver. Pack gauze all around the area of liver to be opened. Treat the disease as already described.

CHAPTER XI.

HERNIA.

Herniotomy.—Formerly herniotomy was considered one of the most beautiful and satisfactory operations in surgery; now, however, it is rarely thought of as a complete procedure, but merely as a preliminary to some one of the operations for the radical cure of the hernia. Under the caption "herniotomy" it will be convenient to describe the methods of combating some of the complications met in cases of irreducible and of strangulated hernia.

FIG. 370.—(*Esmarch and Kowalzig.*)

1. *Incision.*—(A) *Inguinal hernia:* (*a*) Bassini's incision (page 417). (*b*) Macewen's incision (Fig. 370 and page 414). (*c*) Any more or less vertical incision over the hernial swelling and following its long axis. (*d*) Ferguson's incision (page 419).

(B) *Femoral hernia:* (*a*) Bassini's (page 411). (*b*) Vertical.

(C) *Umbilical and ventral herniæ:* Vertical or transverse incision.

2. The skin having been divided, one picks up the subjacent tissues layer by layer and divides them between forceps* (Fig. 371). By this method the hernial sac is soon reached. How may the sac be recognized? Bull says the sac "may be recognized, first, by the presence of the subperitoneal fat immediately out-

*The layers spoken of are not the layers described by the anatomists; such are rarely recognized and never sought, but are such thin sheets of tissue as happen to be picked up by the forceps.

side it; second, by its lead or bluish color; third, by its gliding over the contents of the sac beneath it."

3. A portion of the sac which is non-adherent to its contents is picked up by forceps and cautiously opened with knife or scissors. The first opening is made exceedingly small and is cautiously enlarged until the finger can be introduced and discover the condition of the contents, after which the sac is widely opened.

4. Examination in cases of irreducible and strangulated herniæ almost always shows stricture of the neck by firm surrounding tissues. *Division of stricture:* (A) The general method is to introduce the finger-nail of the left forefinger into the stricture,

FIG. 371.

the back of the finger being against the hernia, keeping it out of the way (Fig. 372). A hernia knife is laid flat on the palm of the finger and pushed along until its blunt nose has got beyond the constricting band. The edge of the knife is now turned and pressed against the stricture in such a way as to make a number of small nicks instead of any definite cut. No sawing motion should be given to the knife and its edge should always be blunt. If these precautions are adhered to, it makes little difference whether one cuts upwards and outwards, upwards and inwards, or only generally upwards, since such a knife, so used, would be extremely unlikely to injure any vessel. Should any vessel be

divided and bleeding occur, it is easy to enlarge the wound and ligate the bleeding point. A herniotomy knife, while convenient, is not necessary—its work can be done by a pair of blunt-pointed scissors. (B) Most surgeons now advocate the division of the constricting tissues from without inwards.

Fig. 372.—(*Esmarch and Kowalzig.*)

5. *Contents of the Sac.*—If the contents consist of healthy gut or healthy non-adherent or non-redundant omentum, they are to be reduced at once. If adhesions are present, they must be gently torn through or divided between ligatures. Sometimes adhesion between gut and sac is so firm that a thin portion of sac has to be cut away and left attached to the gut. If the omentum is redundant, inflamed, or much lacerated from the division of adhesions, most of it should be removed. This is done by placing a chain of ligatures across it (Fig. 373) and cutting away the peripheral portion at a distance of *at least* one inch from the ligatures.

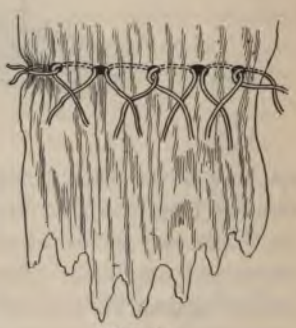


Fig. 373.

Should the gut be gangrenous, it may be dealt with in several ways:

(*a*) The whole gangrenous portion may be excised and the healthy ends of the gut united and reduced at once. Surgeons less sure of their technique or of the assistance of Providence keep the united ends of gut near the hernial canal so that, if union fails or anything goes wrong, drainage may be easy.

(*b*) The gangrenous portion may be excised and the healthy

ends of gut secured in the wound, the resulting fæcal fistula being closed subsequently. This is probably the safest plan for inexperienced surgeons to adopt.

(*c*) It has been advised to perform a laparotomy, find the loop of gut going to and coming from the hernia, and unite them by lateral anastomosis at a distance from the hernia. If this is done, the ends of gut at the hernial opening may be left open and the resulting fistula will either close of itself or be easily dealt with subsequently. A special danger to be feared from this last procedure would be introduction of dirt through the abdominal wound in spite of efforts to shut off the already infected hernial wound.

Unless contraindicated by the weak state of the patient or by the necessity of deep drainage, herniotomy ought always to be followed by an effort after radical cure. (*Vide* "Special Operations.")

FEMORAL HERNIA.

Radical Cure.—Undoubtedly Bassini's method of operation is the best, although it may, perhaps, be improved by adding to it Macewen's method of utilizing the sac to form an intra-abdominal pad.

Step 1.—Make an incision 3 inches long, parallel to and below Poupart's ligament (Fig. 374). The centre of this incision corresponds to the centre of the hernial swelling. Divide the tissues layer by layer between forceps until the sac is reached. The superficial fascia may be surprisingly thick and fatty.

Step 2.—By blunt dissection free the sac from its surroundings.

Step 3.—Open the sac and reduce its contents. (For treatment of complications see page 409.)

Step 4.—(A) Bassini, having separated the sac from its surroundings up to its junction with the parietal peritoneum (of which it is a mere process), transfixes and ligates it at this point and cuts away the peripheral portion.

(B) Macewen, having separated all the sac from its surroundings, pushes his finger through the femoral opening outside the

sac and separates the parietal peritoneum from the parietes for a distance of ¾ inch above the opening. He then treats the sac exactly as in his operation for inguinal hernia, making it into an intra-abdominal pad. (See page 415.)

Step 5.—Make a careful survey as to the position of Gimbernat's ligament, Poupart's ligament, the plica falciformis, and the pectineal fascia. Retract the plica falciformis upwards and outwards. With a full curved needle introduce the suture A–A (Fig. 375) through the inferior and posterior part of Poupart's ligament and the pectineal fascia close to the pubic spine. About ¼ inch external to A–A introduce the suture B–B (Fig. 375). In the same way the suture C is introduced and ought to lie about ½ inch internal to the femoral vein. The sutures A, B, and C are left for the present without being tied.

Fig. 374.

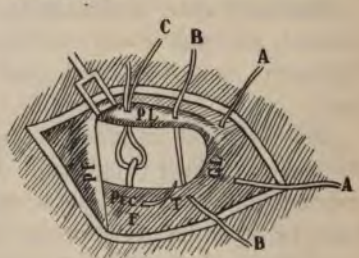


Fig. 375.

Step 6.—The plica falciformis is stitched to that portion of the pectineal fascia which normally forms the posterior wall of the femoral funnel. The insertion of these stitches is shown in Fig. 376 (X–X, Y–Y, Z–Z).

Step 7.—The sutures A–A, B–B, C–C, are tied. This approximates Poupart's ligament to the fascia covering the horizontal ramus of the pubis. The sutures X–X, Y–Y, Z–Z, are tied. This slides the plica falciformis inwards to its normal position or to

an exaggeration of its normal position, and completes the closure of the canal. The long saphenous vein is left to dip unmolested under the inferior end of the plica falciformis. [N. B.—Sutures A–A, B–B, C–C, close the abdominal opening into the femoral canal. Sutures X–X, Y–Y, Z–Z, close the canal itself.]

Step 8.—Closure of the skin-wound.

Roux's Operation.—The hernia is exposed and its sac ligated and excised as in the Bassini operation. The peculiar feature of the operation is the method of closing the femoral canal, as follows: Pass a metal staple obliquely through Poupart's ligament over the crural canal to the inside of the femoral vessels,

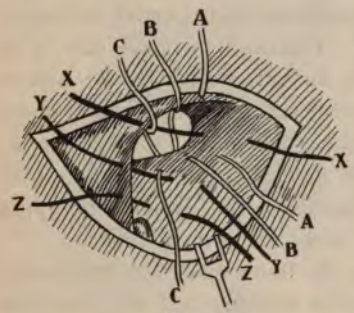


FIG. 376.

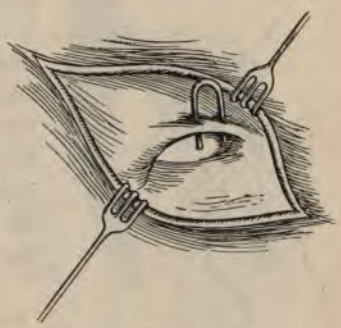


FIG. 377.

carefully avoiding the vein (Fig. 377). Gently hammer the points of the staple into the pubis. The staple or nail must not be inserted too tightly lest Poupart's ligament be injured. J. Crawford Renton reports that Roux has successfully used this method in 60 cases and he himself in 10. The superficial wound is closed in the usual manner.

RADICAL CURE OF INGUINAL HERNIA.

The older operations for the radical cure of inguinal hernia were faulty and unsuccessful because they were based on the idea that the hernia escaped from the abdomen through a *ring*, and that if the *edges of the ring* were brought together, a cure

would be obtained. The scar left by such edge-to-edge closure of the ring can never offer any great opposition to recurrence of the hernia. All the good modern operations are based on the idea that the hernia has originally passed through a more or less oblique canal, which it has converted into a ring-like opening, and that to effect a cure it is necessary to reverse the process and convert the ring into an oblique canal—narrower and more resistant to abdominal pressure than the original canal had been. All operations which carry out the above principle are successful in effecting cures.

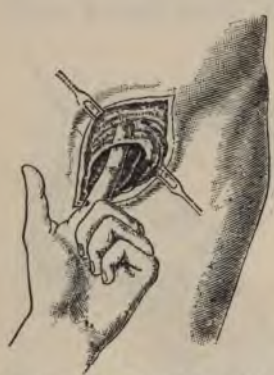


FIG. 378.—(*Esmarch and Kowalzig*).

Macewen's Operation.—1. Make an oblique incision about three inches in length over the external abdominal ring. Practically a good rule is to begin the cut one inch above and to the outer side of the upper limit of the hernial swelling and continue the incision downwards and inwards over the hernial neck. Expose the upper part of the sac of the hernia.

2. By blunt dissection free the sac rom its surroundings and from the spermatic cord, which lies posteriorly. This must be done thoroughly.

3. Reduce the contents of the sac and then open and inspect it. It is often necessary to open the sac before the hernia can or ought to be reduced. (For treatment of complications see page 408.)

4. Pass the finger *outside* the sac through the opening of the parietes and separate the peritoneum (of which the sac is a mere continuation) from the parietes for a space of ¾ inch on every side of the opening (Fig. 378).

5. Should the sac be too voluminous, cut off its distal end, which may be removed or left in the scrotum. Every time it is necessary to make an incision in the sac the position of the cord should be ascertained.

6. A stitch of chromicized catgut is taken through the distal extremity of the sac, which is now hanging loosely through the abdominal wall (Fig. 379), and is there tied. The long end of the suture is passed three or four times from side to side through the sac, so that when pulled upon it throws the sac into folds. The loose end of the thread is threaded on a Macewen hernia needle. The needle, guided by the finger, is passed up *external* to the sac through the abdominal opening and thrust outwards through the whole thickness of the parietes (with the exception of peritoneum and skin) (Fig. 379). If the thread is now pulled, the

FIG. 379.

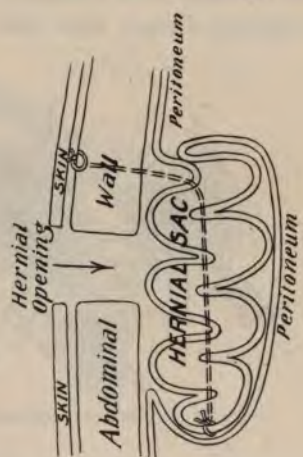


FIG. 380.

sac will be reduced into the belly cavity (external to the peritoneum), and will form a firm, puckered-up pad lying between the peritoneum and the parietes (Fig. 380). The end of the thread is caught by a hemostat and temporarily thrown aside.

7. A Macewen hernia needle is passed through the conjoined tendon from without inwards, and its point, guided by the finger in the abdominal opening, is carried upwards for about ¾ of an inch and once more passed through the conjoined tendon, this

time from within outwards (Fig. 381). By this means a strong chromicized catgut thread is placed in position through the inner wall of the ring.

8. The lower end of the suture is now threaded on an appropriate needle and passed through Poupart's ligament from within outwards a short distance above the spermatic cord (Fig. 381). The upper end of the suture is passed from within outwards through the aponeurosis of the external oblique. We now have a single thread which takes the course seen in Fig. 381. If one pulls upon the ends of the suture, the tissues external and inferior to the opening (viz., Poupart's ligament and the aponeurosis of the external oblique) must slide over those internal and superior

FIG. 381.—*(Esmarch and Kowalzig.)*

(viz., the conjoined tendon), and when the suture is firmly tied, the obliquity of the inguinal canal is restored. The anterior surface of the conjoined tendon is in apposition with the posterior surface of Poupart's ligament. Before the suture is definitely tied the spermatic cord is examined lest too much pressure be exerted on it.

9. The end of the suture used for puckering the sac is now pulled tight and fixed in the belly-wall subcutaneously.

10. The skin-wound is closed.

Macewen makes use of special handled needles, but these are not really necessary. The author has frequently used common

full-curved needles grasped in a needle-holder and found them absolutely satisfactory.

Bassini's Operation.—1. An incision is made parallel to and ½ inch above Poupart's ligament. It begins external to the region of the internal abdominal ring and ends internal to the external ring.

2. A firm aponeurotic sheet (aponeurosis of external oblique) covering the hernia is exposed and divided in the direction of the wound with scissors or on a director (Fig. 382). Thus are formed a superior and inferior aponeurotic flap. The superior

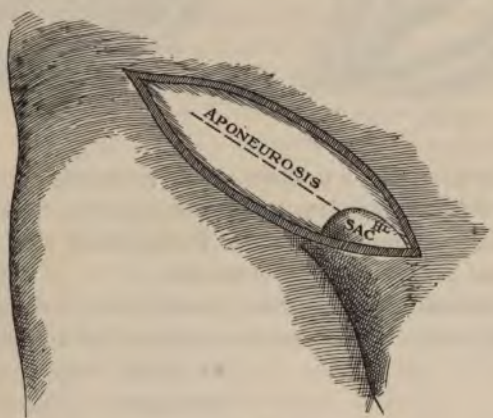


FIG. 382.

flap is separated from the subjacent tissues for a distance of one or one and one-half inches.

3. The hernial sac now lies exposed from its peritoneal origin to the point where it disappears into the scrotum, and is recognized according to the rules described on page 408. With blunt dissection the sac is separated from its surroundings and from the spermatic cord. This must be done thoroughly and carefully. The sac should be opened and its contents reduced or treated as described on page 409.

4. Downward traction being exerted on the sac, its neck is

transfixed and ligated as high up as possible, and the distal portion cut off. The stump should retract into the belly cavity and be lost to sight. Sometimes the neck of the sac is so bulky or of such a shape that ligation is impossible. In these cases the neck of the sac is sewed up and the distal portion removed. By whatever method the neck is closed and divided, special attention

FIG. 383.

FIG. 384.

ought to be paid to the position of the spermatic cord, as this important structure has frequently been injured. Separation of the sac from its surroundings has freshened all the tissues so that if placed in apposition they will unite.

5. The spermatic cord is raised from its bed and held out of the way by a blunt hook. Review of the wound now shows that its upper edge consists of three layers: (A) A deep thick layer, marked muscular flap (Fig. 383). (Internal oblique and transversalis muscles, transversalis fascia, and external margin of the rectus.) (B) Superior aponeurotic flap. (Aponeurosis of external oblique.) (C) The skin. The lower edge of the wound consists of the deep layer of Poupart's ligament on which the spermatic cord normally lies, the inferior aponeurotic flap, and the skin.

FIG. 385.

6. A suture is now passed through the muscular flap (Figs. 383, 384) close to the exit of the cord from the abdomen, and unites

it to the deeper layer of Poupart's ligament. This suture must be so placed as to close the wound beside the cord, but yet not interfere with its circulation. Some surgeons place a suture external to the cord at the point marked x, Fig. 384. This is important. The whole edge of the muscular flap (Figs. 383, 384) is stitched to the deep layer of Poupart's ligament.

7. The cord is now laid on the top of the line of suture and the superior and inferior aponeurotic flaps united over it (Fig. 385).

8. The skin-wound is closed.

Ferguson's Operation.—A. H. Ferguson has noticed that a deficient origin of the internal oblique and transversalis muscles at Poupart's ligament is a fruitful cause of recurrence after operations for the cure of inguinal hernia. To expose and correct such deficiency he has devised the following operation:

Step 1.—Make a semilunar incision, with convexity upwards, from a point in Poupart's ligament 1½ inches below the anterior superior spine to a point on the conjoined tendon near the pubis (Fig. 386). Reflect the flap thus outlined, exposing the aponeurosis of the external oblique and the hernia.

Step 2.—Cut through the external abdominal ring and intercolumnar fascia; separate the longitudinal fibres of the aponeurosis of the external oblique directly over the inguinal canal, far beyond the internal ring, over the surface of the internal oblique, and up under the skin to a point nearly opposite the anterior superior spine (Fig. 386). This exposes all the contents of the inguinal canal, and any deficiency in the origin of the internal oblique and transversalis muscles is seen.

Step 3.—Attend to the hernial contents and sac in the manner already described.

Step 4.—Lessen the size of the dilated internal ring by means of a few stitches (Fig. 387). Suture the internal oblique and transversalis muscles to the inner aspect of Poupart's ligament and restore their normal origin (Fig. 388). The line of suture extends fully two-thirds down the ligament. Take care *not* to split the ligament by grasping with the needle the same longi-

tudinal fibres each time. Close the wound in the aponeurosis of the external oblique. Restore the external abdominal ring. Replace and suture the semilunar skin-flap.

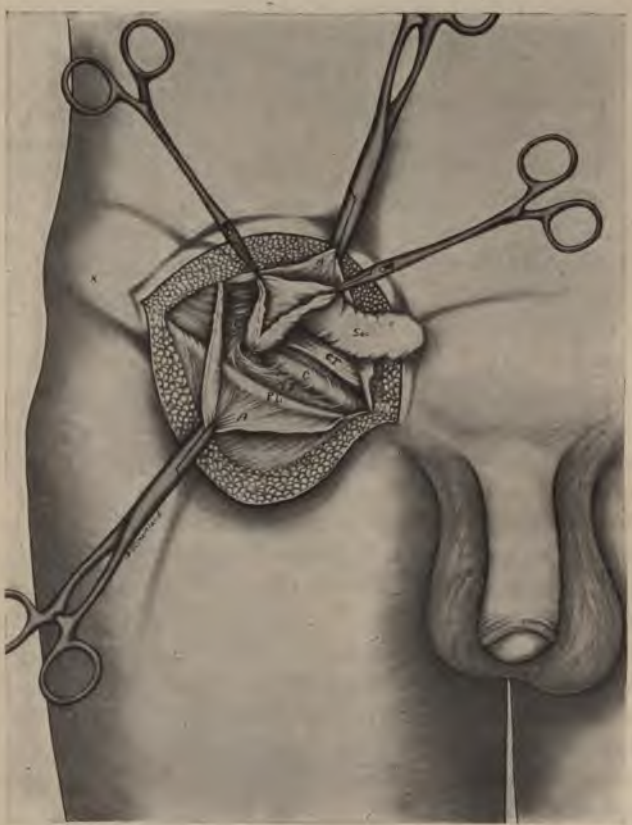


FIG. 386.—(*A. H. Ferguson.*)

To the writer the Ferguson operation seems eminently sane.

After-treatment.—Bassini permits his patients to leave their beds and go to work after the lapse of two weeks. Macewen be-

lieves that no wound is firmly healed after such a short time. When it is possible to carry out the following rules, they will be found exceedingly satisfactory:

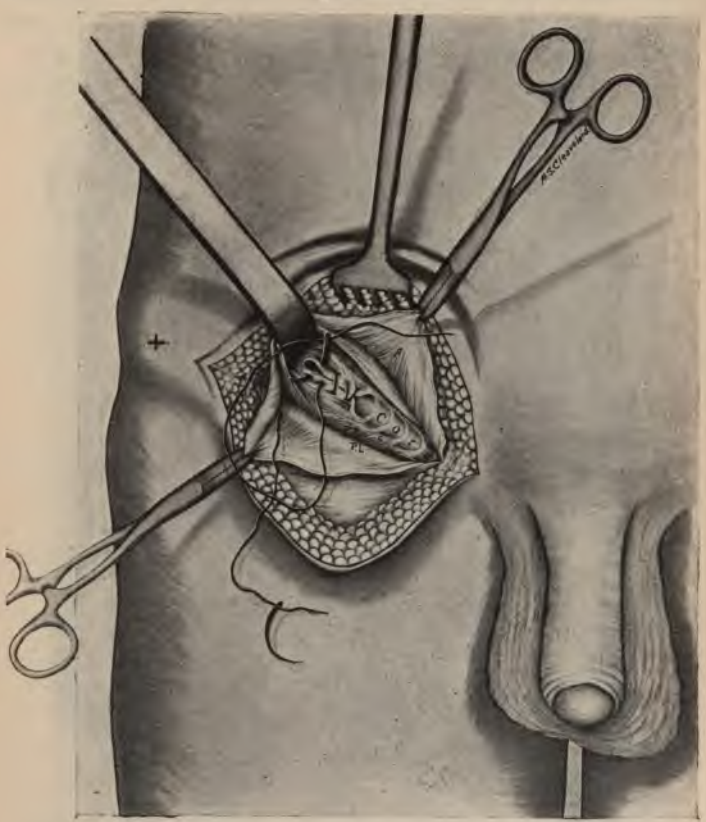


FIG. 387.—(*A. H. Ferguson*)

For a period of four weeks after operation, rest in bed.

For a period of six weeks after operation, when the bowels are

being moved, the patient should be in the recumbent posture so as to avoid strain on the wound.

For a period of three months after operation there should be no hard manual work.

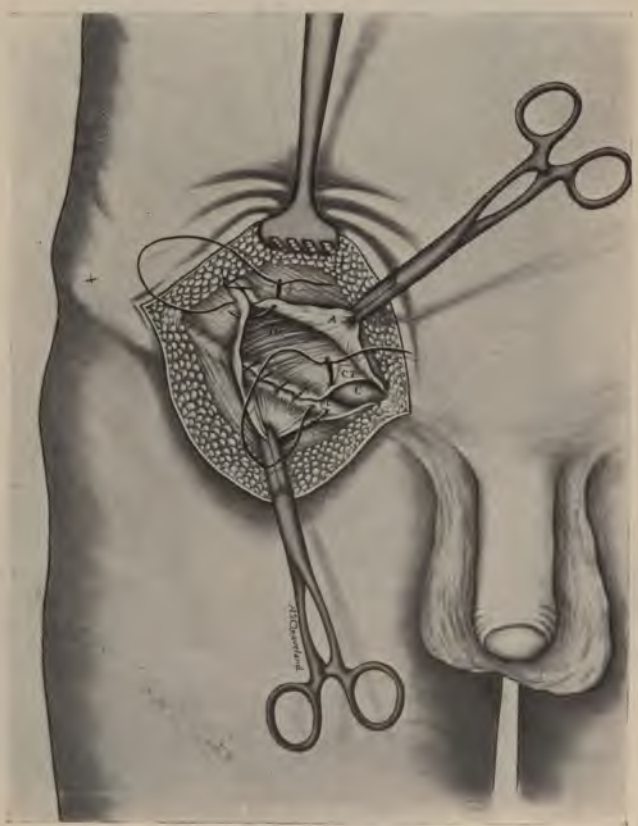


FIG. 388.—(*A. H. Ferguson.*)

The Johns Hopkins Operation for Hernia.—This operation is the result of the experience and ingenuity of the surgical staff

in the Johns Hopkins Hospital. It is based on the original operation of Halsted, modified by himself and Bloodgood. ("Johns Hopkins Bulletin," August, 1903.)

Step 1.—Divide the skin and the aponeurosis of the external oblique as in the Bassini operation. Reflect the aponeurotic flaps.

Step 2.—Split the cremaster muscle and fascia along a line a little above the centre of the cord.

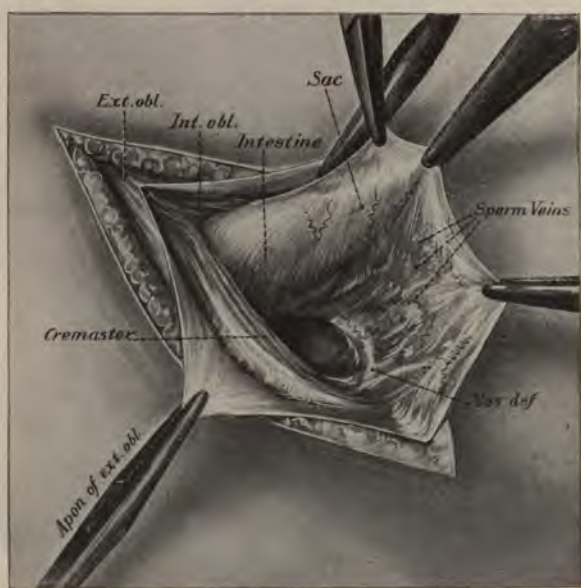


FIG. 389.—(*Halsted.*)

Step 3.—Expose clearly the internal oblique muscle beside the canal.

Step 4.—Examine the hernia and the cord. If the veins are large, and this is usually the case, excise them with very great care to avoid even the slightest extravasation of blood into the tissues about the smaller veins and about the vas deferens which

tures. This step dislocates the neck of the sac in a manner essentially the same as is recommended by Kocher.

Step 6.—Draw the lower flap of cremaster muscle and fascia up under the internal oblique muscle and fix it there by fine sutures which, having engaged firmly a few bundles of the cremaster, perforate the internal oblique, preferably where it is becoming aponeurotic, and are tied on the external surface of the latter (Fig. 390).

Step 7.—Stitch the internal oblique muscle, mobilized and possibly further released by incising the anterior sheath of the

FIG. 393.—(*Halsted.*)

rectus muscle (along with its conjoined tendon) to Poupart's ligament (Fig. 391). Do this in such a manner that the lower edge of the internal oblique is tucked under Poupart's ligament.

Step 8.—Suture the aponeurotic flaps of the external oblique by the Andrews-Halsted method, which makes them overlap (Figs. 392, 393).

Step 9.—Close the skin-wound.

Where the hernial opening is very large and the conjoined

tendon atrophied, a flap of the anterior sheath of the rectus muscle may be reflected outwards and downwards and sutured to the under surface of Poupart's ligament (Fig. 394). This flap of fascia aids in closing the canal by the usual means.

Instead of using a flap of rectus sheath to aid in closing the inguinal canal when the conjoined tendon is insufficient, Bloodgood splits the outer margin of the rectus sheath from the pubic insertion upwards for 2 inches (5 cm.). The muscle bulges from the cut and is sutured to Poupart's ligament.

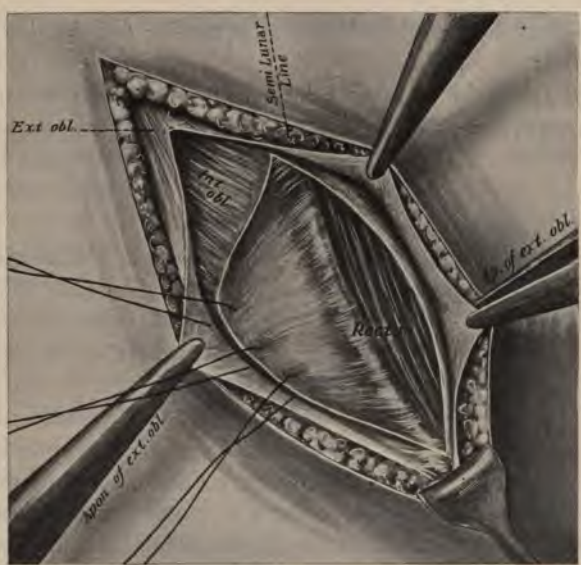


FIG. 394.—(*Halsted*).

En résumé.—The special features of the Johns Hopkins methods of operating are:

1. Excision of the veins of the cord and avoidance of injury to the vas deferens.
2. Use of the cremaster muscle and fascia to strengthen the closure.
3. Overlapping of the various structures brought into apposition.
4. Reinforcement of the lower part of the wound when necessary by a flap of rectus fascia or by rectus transplantation.

UMBILICAL HERNIA.

The classical method of operating in cases of umbilical hernia was to make a vertical incision more or less over the centre of the swelling, open the sac, free the contents, reducing intestine and excising redundant omentum. Ransohoff has shown that much time is lost and danger to viscera incurred by this method of attack, and has laid down the principle that the incision should always be made into the free abdominal cavity at the neck of the sac.

Modified as above, the classical operation may be described as follows:

Step 1.—Make a vertical incision from a point well above the hernia to a similar point below. When passing over the hernia, the incision should be deflected to one side or the other of the umbilicus (Fig. 395).

FIG. 395.

Step 2.—Through the above incision without opening the sac dissect down to and freely expose the aponeurotic structures *at one side* of the neck of the hernia.

Step 3.—Open the sac at its neck; reduce any extruded gut. Ligate and divide redundant omentum and reduce the omental stump. Place a gauze pad against the opening into the abdomen and excise the hernial sac, the remains of omentum which it may contain, and such redundant skin as may require removal. This excision may be done rapidly, as all danger of injury to gut, etc., has been avoided by its early isolation and reduction.

Step 4.—Close the peritoneal wound by a row of catgut sutures.

Step 5.—By sharp and blunt dissection open the rectus sheath on both sides of the wound and expose the edge of both recti muscles.

Step 6.—Unite the posterior layer of rectus fascia or sheath by sutures. Suture together the rectus muscles. Unite the anterior layer of rectus fascia. Close the skin-wound.

The above is a good operation in cases of small hernia; but, as the Mayos have shown, when the hernia is large, and, as is usually the case, the patient is fat, there is a wide separation between the recti and these muscles are themselves atrophied. The classical operation has therefore proved inefficient in the very cases where success is most to be desired. The Mayos' operation does not seek to obtain muscular apposition; it depends for success on the formation of a strong aponeurotic barrier.

The Mayos' Operation (Figs. 396, 397, 398).—*Step* 1.—Make *transverse* elliptical incisions around the umbilicus and the hernia. Deepen these to the base of the hernial protrusion.

Step 2.—For an inch and a half in all directions from the neck of the sac carefully expose the aponeurotic structures.

Step 3.—Divide, in a circular manner, the fibrous and peritoneal coverings of the hernia at the neck. Expose the hernial contents. If viscera are present, separate the adhesions and reduce. Ligate the contained omentum and remove it with the entire sac of the hernia.

Step 4.—Grasp with forceps and approximate the margins of the ring. In whatever direction overlapping proves easiest lies the proper direction for closure.

Step 5.—Incise the aponeurotic and peritoneal structures of the ring for a distance of one inch or more transversely to each side. Separate the peritoneum from the under surface of the upper of the two flaps thus formed.

Step 6.—Beginning one inch or more above the margin of the upper flap, introduce three or four silver wire mattress sutures (Ochsner and others use chromicized catgut), the loop firmly grasping the upper margin of the lower flap. Make sufficient traction on these sutures to permit of closure of the peritoneum with a continuous catgut suture. Twist or tie the mattress sutures, sliding or pulling the entire lower aponeurotic flap into the space between the peritoneum and aponeurosis above.

Step 7.—With catgut, suture the lower edge of the upper aponeurotic flap to the aponeurosis below. Close the superficial wound.

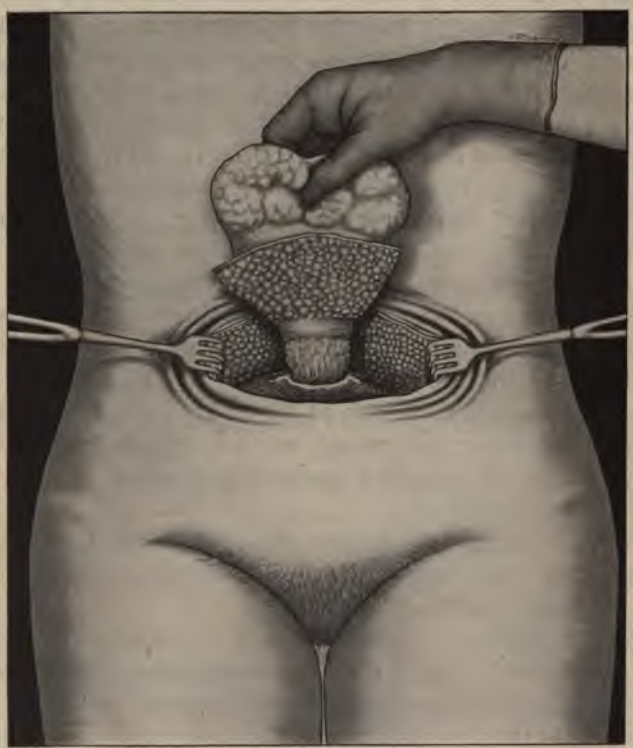


FIG. 396.—(*Mayo.*)

When a large defect in the abdominal wall cannot be closed in the above manner or in some modification thereof, closure has been effected by means of a perforated celluloid plate (McCosh) or of a silver wire meshwork (Phelps, Willy Meyer). Meyer is very urgent in the praise of this method of closure.

The meshwork or fence of silver wire seems to be well borne by the tissues and to form the nucleus of a strong mass of connective tissue.

FIG. 397.—(*Mayo.*)

Ventral herniæ of all varieties are to be treated on the same principles as are advocated for umbilical herniæ. Undoubtedly the best treatment for post-operative ventral herniæ is, to use an

Irishism, not to have them. For this purpose nothing is better than attention to cleanliness, careful closure of the parietes in their anatomic layers, and absolute avoidance of strain until the

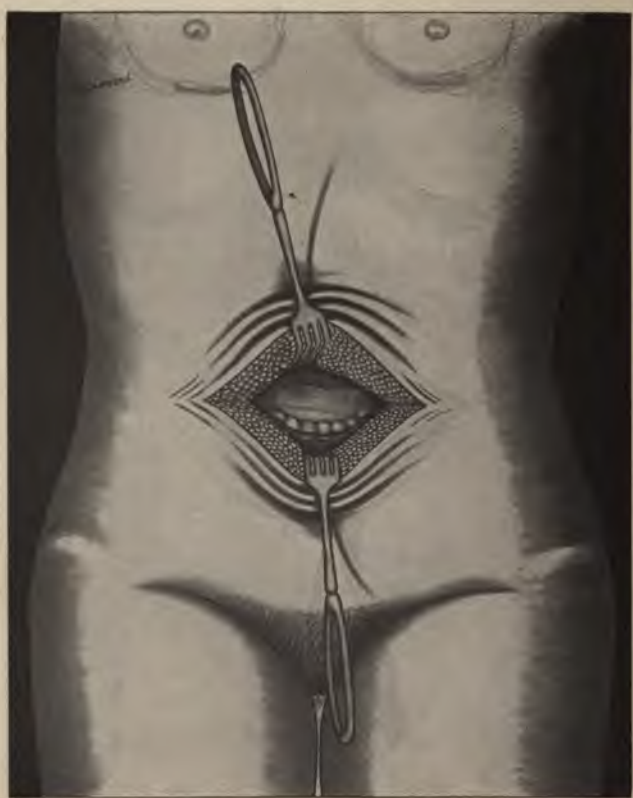


FIG. 398.—(*Mayo.*)

embryonic tissues necessary for the repair of abdominal wounds have had time to become mature.

CHAPTER XII.

RETRO-PERITONEAL AND DIAPHRAGMATIC HERNIA.

RETRO-PERITONEAL OR INTERNAL HERNIA.

Normally the peritoneal cavity is provided with a number of apertures or fossæ which, under ordinary circumstances, are entirely harmless, but which may become dangerous owing to various anomalies of development and to adverse circumstances. The following are the most important of these structures:

1. The foramen of Winslow. In a few cases small intestine has entered the lesser peritoneal sac through this opening. The condition, if found during life, demands that the herniated intestine be reduced into its proper location and that the foramen be lessened in size or obliterated. Probably the trauma due to the hernia and its reduction will produce enough plastic peritonitis to effect obliteration; a gauze or cigarette pack introduced into the foramen would act similarly, or one or two catgut sutures may be judiciously introduced.

2. Recessus duodenojejunalis. At the point where the duodenum passes into the jejunum a fold of peritoneum, containing the inferior mesenteric vein, forms a semilunar opening to the left of the origin of the jejunum (Fig. 399). Usually this opening or recess is shallow and not wider than a man's thumb. Jonnesco and others have described several varieties of recess in this situation, but for our purposes the recognition of its existence and of its proneness to vary suffices. Intestine may bore its way into the recess described, enlarging the opening and forming a retroperitoneal hernia (Treitz's hernia). The pouch formed by the herniated gut may stretch to the left under the descending colon

and downwards to the pelvis. Upwards the hernia may pass under the root of the transverse mesocolon to a position behind the stomach and spleen. Strangulation is rare. It is commonly supposed that small intestine alone is involved, but Freeman ("Transactions American Surg. Assoc.," 1903) describes a case in which the sac contained the entire small intestine, the cæcum and a portion of the colon, which was strangulated. A. Narath ("Archiv. f. klin. Chir.," lxxi, 911) reports a case in which prior

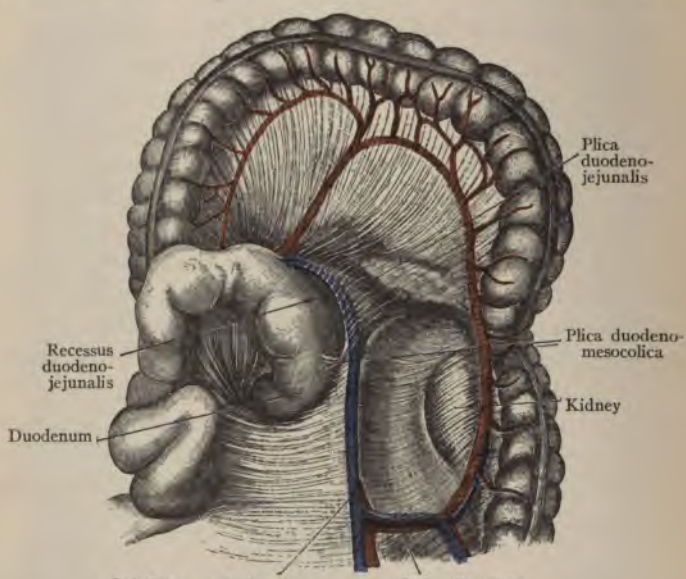


FIG. 399.—(*Zuckerkandl.*)

to operation the diagnosis was pyloric or gall-bladder tumor. When the abdomen was opened above the umbilicus, the small intestines presented *in front* of the great omentum, the transverse colon, and the stomach. When the small intestine was pulled out of the belly cavity for inspection, the cæcum and vermiform appendix followed, appearing *above* the lesser curvature of the stomach. The case was one of hernia through the recessus duodenojejunalis; the gut passed up behind the stomach and

then forwards through the gastro-hepatic omentum. Reduction was easy, and the duodenojejunal opening was closed by a few stitches of catgut.*

3. Pericæcal fossæ. Three fossæ exist in the neighborhood of the ileo-cæcal junction (Fig. 400): (*a*) Ileo-colic fossa, which lies above the ileum and below the ileo-colic fold containing the colic branch of the ileo-colic artery. (*b*) Ileo-cæcal fossa. The orifice of this fossa is situated below the ileum, where it joins the cæcum.

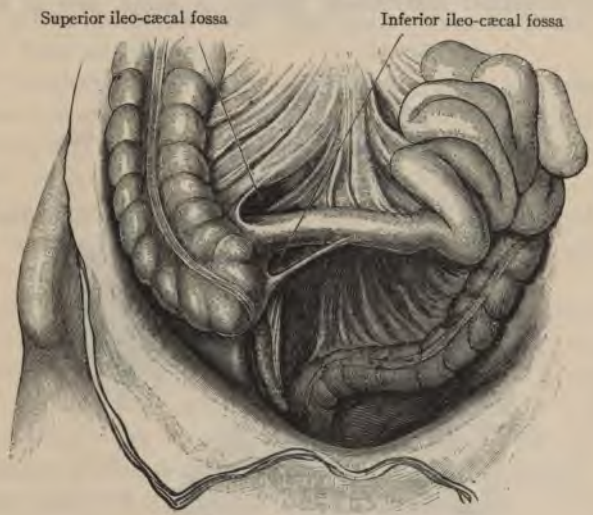


FIG. 400.—(*Zuckerkandl.*)

The fossa may be large and extend upwards posterior to ascending colon as far as the right kidney. (*c*) Subcæcal fossa. This fossa lies beneath the cæcum and external to the meso-appendix and meso-cæcum. Any one of the pericæcal fossæ may be the site of an internal hernia, especially if its normal relations have been altered by attacks of appendicitis. The fossæ are also of

* For extended information on this subject the reader is referred to Freeman's paper already mentioned, to Moynihan's work, "Retroperitoneal Hernia," London, 1899, to Jonnesco's "Hernies internes rétro-péritonéales," Paris, 1890.

surgical importance, as they may be filled with the products of inflammation in appendicitis, and into one of them the appendix itself may be herniated.

4. The intersigmoid fossa (Fig. 401). On the lower or left surface of the meso-sigmoid a fossa may exist which is variable in size. A few cases of hernia have been described in which this fossa formed the sac.

Many operations have been undertaken for the treatment of obscure intestinal obstruction, chronic or acute, and in many

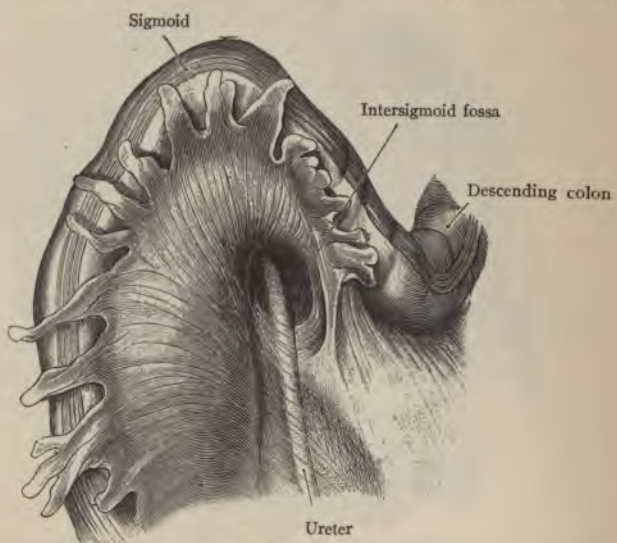


FIG. 401.—(*Zuckerkandl.*)

of these, symptomatic recovery has ensued, although no cause was discovered during the operation. Undoubtedly in many of these cases an internal hernia has been overlooked or has been reduced, unknown to the operator, by the manipulations necessary in exploration.

This short chapter has been written to direct the attention of the junior surgeon to the probable sites of internal herniæ. The author believes that internal herniæ are very much more common than statistics would indicate.

Occasionally herniæ becomes so large and contain so many organs that these organs may be said to have lost their right of domicile in the abdomen, and hence reduction, whether operative or non-operative, becomes impossible or unjustifiable. In other cases adhesions uniting the hernial contents to each other and to the sac constitute a condition which, either alone or in combination with a poor state of the general health, contraindicate any attempt at reduction. In such cases when strangulation or obstruction becomes evident, what means have we to overcome their disastrous results?

If the strangulation is due to constriction at the hernial orifice, common sense tells us to divide the constriction by free, open incision, and, contrary to the practice in "radical cure," to endeavor to retain the increased patency of the opening between the abdominal cavity and the hernial sac. In other words, our aim ought to be to make the abdominal cavity and hernial sac as nearly as possible one.

Usually in large herniæ nature has so dilated the abdominal orifice that strangulation at this point is rare. It is more common to find that adhesions, bands, diverticula, etc., in the hernial sac itself are the cause of strangulation. As Madelung ("Archiv f. klin. Chir.," lxxiv, 60) points out, gangrene may be far advanced in herniæ of this class, and symptoms be almost absent; thus during operation one may be compelled to excise a considerable amount of diseased gut, joining the afferent and efferent sections by anastomosis or enterorrhaphy, or may establish a fæcal fistula. Some surgeons have, on general principles, excised a mass of herniated gut, so that reduction of the remainder became possible and a radical cure could be effected.

In very large herniæ there is always some obstruction to the onward passage of fæces; this obstruction varies from time to time. Mild exacerbations are usually successfully treated by purgation, enemata, rest in bed, massage, etc., but occasionally operative interference becomes necessary. Madelung writes: "In many cases, especially the old and feeble, when coprostasis has continued for a long time, it is very proper to establish

a fistula in the afferent gut. Under local anæsthesia this is absolutely without danger even in the most debilitated. The fistula should be small, about the size of a medium-sized Paquelin cautery point. It should only drain part of the intestinal contents, acting as a kind of safety-valve." When the patient is strong enough to withstand a more severe operation, intra-abdominal anastomosis between the afferent and efferent loops of gut serves to segregate or exclude the affected viscera (see "Intestinal Exclusion"). It is, of course, impossible to formulate precise rules for the operative treatment of irreducible herniæ, but it is hoped the above brief remarks may aid the inexperienced practitioner in an emergency.

DIAPHRAGMATIC HERNIA.

The diaphragm is the site of several actual or potential openings, the principal being that between the costal and sternal origins of the muscle, and known as the foramen of Morgagni. Hernia through Morgagni's foramen is known as parasternal hernia, and is provided with a double sac, of pleura and peritoneum. For our purpose it is useless to differentiate between the so-called true hernia and the false, where, owing to injury, there is a prolapse of abdominal organs into the thorax. Very few diaphragmatic herniæ have been diagnosed; most have been discovered during operation or autopsy. The commonest cause of diaphragmatic hernia is trauma, usually from knife or bullet, and the proper treatment is immediate operation. In Lacher's statistics of 36 traumatic cases not submitted to operation, 15 died from hernia after periods varying from a few days to a month, and 10 died in from five to twenty years from the same cause. A wound of the diaphragm when left to itself is very liable to heal, but the scar remains weak and hernia is the common result. This being true, the best treatment for traumatic diaphragmatic hernia is prophylactic. The wound of entrance is almost always in the thorax. Enlarge the wound, excise two inches or more of one or two ribs, as may be required to give

room. Note if the pleura is or is not injured. In a case operated on by the writer the pleura was uninjured, though the diaphragm was penetrated and omentum was present in the thorax. Expose and examine the diaphragm. If the diaphragm has been penetrated and omentum or hollow viscera present, examine and repair any injury they may have sustained. Open the abdomen either by a median or lateral incision, or, as Neugebauer ("Archiv f. klin. Chir.," lxxiii, 1014) did, by a cut dividing the costal arch. It is usually easier to reduce the prolapsed organs after the abdomen has been opened, and it is necessary to explore the abdomen in the search for further injuries. If no abdominal contents are prolapsed through the diaphragmatic wound, open the abdomen and search for any injuries to its contents. If the liver is injured, treat such injuries *secundem artem.* Close the wound in the diaphragm with sutures introduced by the transthoracic route. Close the wounds in the abdomen and thorax with or without drainage. In 52 cases of diaphragmatic suture (where there was no *strangulated* hernia) the mortality was 9.6 per cent. when the transthoracic route was adopted; in 10 similar cases when the abdominal route was used the mortality was 50 per cent. Of the cases of strangulated diaphragmatic hernia collected by Neugebauer, all those operated on through the abdominal route died; one out of two operated on through the thorax lived. The only case of non-strangulated diaphragmatic hernia submitted to radical cure (Llobet's case) lived after a transthoracic operation. When operation is performed for obscure abdominal lesions, we ought to remember and look for diaphragmatic hernia, and if such is found, we ought *not* to waste time endeavoring to reduce it from the abdominal side, but proceed at once to open the chest. Suture of the diaphragm from below is extremely difficult and necessitates very much disturbance in a region rich in important nerves. Prolapsed masses which it is impossible to reduce from the abdomen alone are easily reduced or slip back of themselves as soon as the chest is well opened. That the dangers from pneumothorax are not so great as is usually imagined is shown by the small mortality (9.6 per cent.) after recent

wounds of the thorax. Furthermore, if the hernia is reduced through the abdominal route, pneumothorax must occur immediately the hernia ceases to plug the diaphragmatic wound, while the establishment of pneumothorax prior to reduction aids marvellously in obtaining this reduction.

PART IV.—THE GENITO-URINARY SYSTEM.

CHAPTER I.

OPERATIONS UPON THE KIDNEY.

METHODS OF EXPOSING THE KIDNEY.

I. Posterior or Lumbar Route.—There are two positions in which the patient may be placed:

(*a*) The classical or lateral posture. Place the patient upon his sound side with his back near the edge of the operating table and his thighs and knees well flexed. To increase the space between the thorax and ilium, place a roll-shaped, firm pillow under the loin of the sound side. The surgeon stands at the patient's back.

(*b*) The prone position. This position is the best for most purposes. Lay the patient prone upon the table. Place a large pillow (Edebohls' air-cushion, 12 inches long by 8 inches in diameter, is excellent) beneath his abdomen with its long axis at right angles to the long axis of the body. This lifts the kidneys into the field of operation and gives the widest possible costo-iliac space.

(A) *Vertical Incision* (Simon).—Recognize the last rib and the erector spinæ muscle. Make a vertical incision from the last rib downwards, parallel and close to the outer edge of the erector spinæ muscle. This penetrates the skin and subcutaneous tissue and extends nearly to the crest of the ilium. The latissimus dorsi is now seen. *Separate* but do not cut its muscular fibres (Figs. 402 and 403). The erector spinæ muscle presents. Retract it inwards, but do not open its sheath. Expose and open

the sheath of the quadratus lumborum along its outer margin for the full length of the wound. As the pleura occasionally extends below the last rib, it is wise to avoid the neighborhood of this rib while making deep dissection. By keeping one inch below the rib, all danger to the pleura is avoided, and at a little later period in the operation the wound can be safely enlarged upwards under guidance of the finger. As soon as the fascia lumborum or transversalis fascia, lying in front of the quadratus lumborum, is divided, perirenal fat bulges into the wound. Remember that the last thoracic, iliohypogastric, and ilio-inguinal

FIG. 402.—(*Edebohls, 'Annals of Surg.'*)

nerves lie between the quadratus muscle and the kidney. These nerves, when met with, should be carefully pulled aside, or if it is necessary to divide one of them, the severed ends ought to be caught up in a suture, so that when the operation is completed and the wound is being closed, they may be once more united (Edebohls). Failure to attend to this point may lead to an annoying and persistent pain in the thigh after operation. When the perirenal fat is exposed, tear through it and expose the kidney.

If the above incision does not give sufficient room, make a

small transverse incision through the outer fibres of the quadratus muscle near the ilium; this simple proceeding is of great aid. To gain more room, some surgeons have recommended excision of the last rib, but this has not proved of much value. A better suggestion has been made, namely, to fracture the last rib and turn it upwards. It is easy to deliver the kidney on to the back through this incision.

(B) *Oblique Incision* (Bergmann).—From the outer edge of the erector spinæ, at the level of the twelfth rib, make an incision downwards and outwards towards the junction of the outer and middle third of Poupart's ligament. The length of the incision varies with the work to be done and the size of the operator's hand. It must be large enough to give free access to the kidney. A cut four inches in length is generally sufficient for exploratory purposes and may readily be enlarged. The lower border of the latissimus dorsi presents and must be divided. Layer by layer cut through the external oblique, the internal oblique, the transversalis muscle. Under the last-named muscle lies the transversalis fascia. Make a small opening in the fascia and, guided by the finger passed through the opening, divide it for the whole length of the wound. The quadratus lumborum lies at the upper and inner part of the wound and is either retracted towards the spine or divided as may be convenient. After division of the transversalis fascia the perirenal fat presents and is torn through until the kidney is reached. During the deeper

FIG. 403.—(*Esmarch and Kowalzig.*)
1. External oblique. 2. Internal oblique. 3. Transversalis. 4. Transversalis fascia. 5, 6, 7. Lumbo-dorsal fascia. 8. Sacro-spinalis. 9. Quadratus lumborum. 10. Psoas. 11. Colon. 12. Pancreas. 13. Kidney. 14. Spleen.

dissection care must be taken not to injure the pleura should it descend below the last rib.

(C) *Triangular Incision* (König).—From the outer edge of the erector spinæ, at the level of the twelfth rib, cut downwards parallel and close to the erector muscle until the iliac crest is reached. From the lower end of the wound make a curved incision directed towards the navel and reaching to the outer margin of the rectus abdominalis. The division of the deeper structures is carried out in the manner already described. Any parietal peritoneum which may be exposed is pushed aside. Very free access to the kidney or to tumors of that organ is attained.

(D) *Zuckerkandl's Incision.*—From the outer edge of the erector spinæ, at the level of the twelfth rib, cut downwards to the middle of the iliac crest; from the latter point cut forwards to near the anterior superior spine of the ilium. The deep dissection is done as already described.

(E) *Trap-door Incision* (Bardenheuer).—From the upper and lower extremities of the vertical incision (A) make horizontal cuts parallel to the lower edge of the thorax and to the iliac crest respectively. If these cuts run forwards, a trap-door is formed which can be reflected or retracted anteriorly; if they run backwards (*i. e.*, towards the spine), one which can be turned backwards is the result. In some cases it may be desirable to form both an anterior and a posterior trap-door flap.

Should the peritoneum be opened during the operation, it ought to be closed at once by suitable sutures.

(F) *C. T. Parkes' Incision.*—Make a curved incision from a point two inches above the anterior superior spine to the tip of the last rib. Expose the fascia transversalis. With the finger, dissect well behind the tumor of the kidney. Having separated all the parts, make a straight incision backwards from the first cut and half-way between the crest of the ilium and the last rib. An excellent exposure is obtained of the kidney, vessels, and ureter.

II. Anterior or Abdominal Route.—If the kidney to be exposed is *very* large, an incision may be made over the tumor at any place which may seem suitable or advisable. Such an

incision will be either vertical or oblique (running from above downwards and inwards). Langenbuch's incision will generally be found to be the best, as it gives free access to the renal vessels and avoids unnecessary exposure of the intestines.

Langenbuch's Method.—From a point immediately below the ribs and about three inches from the middle line cut downwards for a distance of four inches. Find the outer edge of the rectus muscle (linea semilunaris). Cut down to the peritoneum, following the semilunar line. Open the peritoneum carefully in the same manner as the sac is opened during a herniotomy. Introduce the hand and examine the opposite kidney and ureter. This is a most important precaution, and must always be observed. The opportunity afforded to examine the opposite kidney constitutes one of the advantages of the abdominal route over the lumbar. The opposite kidney and ureter being found healthy, the intestines are covered with a large flat gauze pad and kept out of the way. The outer surface of the mesocolon is exposed and a small hole made in its outer layer. This hole is enlarged by tearing. The vessels which pass through the mesocolon lie close to its inner layer, and thus injury to them is avoided. Through the opening in the mesocolon the kidney is easily and completely exposed.

Nephropexy or Nephrorrhaphy.—*Method I.*—Expose the kidney by incision A or B. Excise most of the fatty capsule lying posterior to the kidney. An assistant with his fist pressing on the belly pushes the kidney up into the loin. Pass a curved needle, armed with a thick suture, through the muscles and fascia of the back which form the outer edge of the wound, through the remnants of the fatty capsule, and into the kidney parenchyma near the outer convex border of the kidney. The needle penetrates the kidney to a depth of about one-half inch and emerges at a point about three-quarters of an inch internal to its point of entrance. After emerging from the kidney the needle passes through the remnants of the fatty capsule and the muscles and fascia of the back which form the inner edge of the wound. Three such sutures are put in place, one at the upper end of the kidney, one at the lower, and one in the

middle; but none of them are tied. The deep parts of the wound in the back are now approximated by buried sutures. When this is done, the three sutures which pass through the kidney are *carefully* tied. No pulling upon these important sutures is allowable, otherwise they would cut their way out of the friable kidney. This is the reason for closing the deep parts of the lumbar wound (*i. e.*, the parts through which the kidney sutures pass) before the kidney sutures themselves are tied. The superficial wound is closed. Some surgeons, notably Newman, pass a drainage-tube through the wound to the kidney so as to produce a local irritation and thus aid in the formation of adhesions. *Suture material:* Mildly chromicized catgut, kangaroo tendon, silk or silkworm-gut.

Method II.—Is the same as Method I, except in one particular: After the kidney is exposed a longitudinal incision is made through the fibrous capsule, which when turned outwards and inwards like the lapels of a coat, forms an outer and an inner flap. The parenchyma of the kidney is thus left exposed for a width of about three-quarters of an inch throughout almost the whole length of the posterior surface of the organ. The sutures are introduced as before, except that when entering and leaving the kidney they pass through the folded flaps of fibrous capsule.

The advantages claimed for this method are (*a*) that better union takes place between the kidney and the muscles and fascia of the back; (*b*) that the threads passing through the folded back flaps of fibrous capsule are less liable to cut their way out. The objections urged against the method (especially by Albarran) are (*a*) that decortication is unnecessary; (*b*) that sclerotic changes are more liable to occur and injure the kidney.

Method III.—The kidney is exposed by incision B. At a point opposite the lower extremity of the kidney (when it is pushed up into its normal position) a pocket is formed by separating the transversalis fascia from the more superficial structures. Into this pocket the lower end of the kidney is snugly tucked. One or two sutures unite the kidney to the surrounding muscles and fascia and the wound is closed. Pean is a supporter of the above operation.

Method IV (Israel's).—Expose kidney by incision A. Recognize the last rib. Split the fibrous capsule of the kidney so as to lay bare a narrow strip of cortex reaching nearly the whole length of the organ. Through the upper part of the posterior surface of the kidney pass a *double* suture of thick catgut (Fig. 404, A A^1, a a^1). Cut the loop of the suture so as to leave four ends of suture on which needles are to be threaded. Make a knot on the double thread of catgut where it enters and where it leaves the kidney (z–z). One of the threads emerging from the outermost part of the kidney, having been armed with a needle, is passed, first, through the fatty capsule of the kidney, and then between the periosteum and the posterior surface of the twelfth rib (Fig. 404, A A^1). The other end of thread emerging from the kidney at the same point is passed subperiosteally in front of the twelfth rib in such a manner that the two ends surround the rib under its periosteum. The two threads are knotted together. The two ends of the catgut threads which emerge from the inner part of the posterior surface of the kidney (a a^1) are separately passed through the fatty capsule, and the muscles and fascia on the inner side of the lumbar wound. These two ends of suture are now tied together, care being taken not to tie so tightly as to make the thread cut through the renal tissue. The result of the above manœuvre is to sling the kidney by a double thread the outer end of which surrounds (subperiosteally) the twelfth rib; the inner end is fastened to the muscles and fascia forming the inner wall of the lumbar wound. Two more double cat-

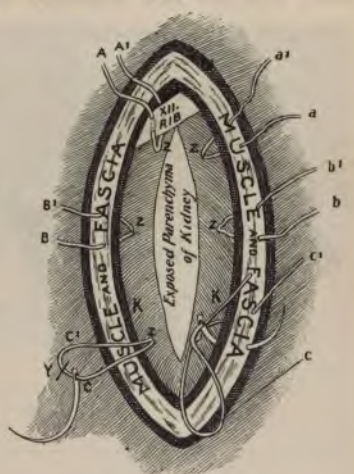


FIG. 404.

gut sutures are passed through the kidney in the same manner and their loops cut so that each double suture becomes two distinct sutures passing through the kidney together. The ends of suture emerging from the inner part of the kidney are each separately passed through the muscles and fascia on the inner side of the wound (B B^1, C C^1) and there tied together; those emerging from the outer part of the kidney are similarly passed through the muscles and fascia on the outer side of the wound (c c^1, b b^1) and there tied. The threads emerging on the outer side of the wound are tied together; those emerging on the inner side are tied together; *none* are tied across the wound. The lumbar wound is closed by deep and superficial sutures.

FIG. 405.

Method V (Jonnesco's Operation).—*Step* A.—Beginning at the outer edge of the erector spinæ muscles, make an incision from four to five inches in length along the inferior border of the twelfth rib. If the twelfth rib is short, the incision is continued along the eleventh rib. Expose the whole of the twelfth and if necessary part of the eleventh rib. Cut through the transversalis fascia and expose the kidney, which an assistant presses up into the wound. Excise most of the fatty capsule. Split the fibrous capsule of the kidney longitudinally and turn outwards and inwards an outer and an inner capsular flap (as in Method II).

Step B.—Pass a curved needle (Emmet's needle) through the following structures in the order named—the skin (one inch distant from the lower edge of the wound), muscles of sacro-lumbar mass, deep aponeurosis, folded inner flap of renal capsule (formed in Step A), the kidney parenchyma, the folded outer

flap of renal capsule, the periosteum of the external surface of the twelfth or eleventh rib, and the muscles and skin of the superior edge of the wound (Fig. 405). Thread into the needle the end of a silver wire suture; withdraw the needle. Reintroduce the needle in the same manner at a point ½ inch distant and pull through the other end of the silver wire suture. The result is that a U suture is in place. Two such suffice. Through the loop of each U is placed a small roll or pad of gauze to prevent the skin being cut. The other ends of each U suture are twisted

FIG. 406.—(*Edebohls, "Annals of Surg."*)

together over a pad of gauze. No tension is put on the sutures lest they cut the kidney tissue; their function is to suspend the kidney.

Step C.—Close the wound with catgut or silkworm-gut sutures.

The dressings are left untouched for ten days, after which time all the non-absorbable sutures are removed.

Method VI (Edebohls' Operation).—*Step* 1.—Expose the kidney by Method A, patient being in prone position.

Step 2.—Deliver the kidney through the wound and excise the fatty capsule.

Step 3.—Decapsulate the kidney and introduce suspension sutures of forty-day chromic gut, as shown in Fig. 406.

Step 4.—Reduce the kidney and pass the sutures from within outwards through the whole thickness of the parietes except the skin, and tie them as in Fig. 407.

Step 5.—Close the lumbar wound.

FIG. 407.—(*Edebohls, "Annals of Surg."*)

In performing this operation do not endeavor to anchor the kidney at as high a level as its normal site, and be careful not to cause any kinking of the ureter. The main principle of the operation is to bring a large area of decorticated kidney into contact with a corresponding area of the quadratus muscle denuded of its fascial coverings.

In all the preceding methods of nephropexy the aim of the surgeon has been to suture or sling the kidney to the posterior parietes. Harris has shown that in cases of mobile kidney there is a separation of the posterior peritoneum from the parietes, and that the attachments of the ascending mesocolon are loosened. The result is an absence of normal support to the kidney and the presence of a ptosis of the ascending colon.

Harris' Operation.—Place the patient in the prone position; expose the kidney and bring it out through the wound. Retract the edges of the wound and observe the post-peritoneal cavity into which the kidney has been in the habit of gliding and note the position of the ascending colon. By a few carefully placed catgut sutures obliterate the above-named space, and the essential element of the Harris operation is completed. Prepare the kidney for suture, reduce it, and fix it to the parietes by one of the methods already described.

The Harris operation is the only one in which any attention is paid to the fact that nephroptosis is often merely one part of a condition of general visceral ptosis, and in which an endeavor is made to correct part of the visceral ptosis by fixation of the colon (colopexy) while the post-peritoneal space is being obliterated.

Mobile kidney is exceedingly common, and in the majority of cases presents no symptoms. When symptoms are present, they may be really those of neurasthenia, in which case fixation of the kidney can scarcely be expected to do more than give mental relief. Of course, cases do occur in which the mobility of the kidney is the causative factor, where tension exerted on the structures at the hilus gives rise to trouble and where kinking or displacements of the ureter occasion distressing symptoms and conditions. It is in this comparatively small class of cases that nephrorrhaphy gives gratifying results.

Alglave ("Rev. de Chir.," Dec., 1904) describes a number of cases in which ptosis of the kidney led to a descent of the upper part of the ascending colon, the cæcum remaining fixed. The result of this is an abnormal flexing of the gut, with dilatation and most obstinate constipation. Colitis and pericolitis are commonly present, with many adhesions. According to Alglave, these accidents are secondary to the nephroptosis, but are often so thoroughly established that nephropexy is insufficient to correct them. The author has met this condition in a number of cases and has seen fair results follow liberation of the gut from its

adhesions. In bad cases exclusion of the ascending colon by uniting the ileum to the descending colon (see "Intestinal Exclusion") will be found serviceable.

Many surgeons, when operating on the right side, before proceeding to treat the kidney itself in the operation of nephrorrhaphy, open the peritoneum freely, find the ascending colon, draw it out of the wound, and follow one of its longitudinal bands to the appendix. Excise the appendix whether diseased or not. In the hands of an expert this additional step consumes only a very few minutes, and as one eminent surgeon remarked to the writer, "If any operator ever gets close to my appendix, I will never forgive him should he not remove it." The same surgeons who advocate appendicectomy as a step in the operation also advocate exploration of the biliary passages as a routine measure. The inexperienced operator is advised not to add the above-mentioned steps to the operation of nephropexy, as in his hands the extra risk incurred will probably more than balance the benefits which may accrue.

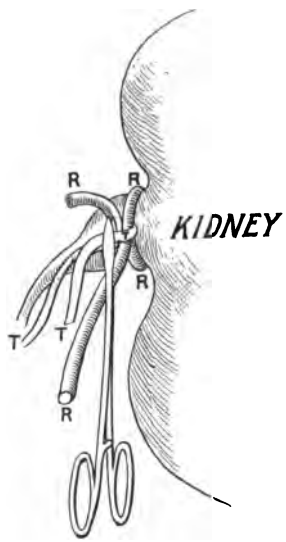


FIG. 408.
R. Rubber tube or band. T. Tape placed over the crossing-point of rubber tube, and held by forceps. It is just as good to fix the rubber by the forceps without the use of the tape.

Exploration of the Kidney.—Expose the kidney, preferably by Method A, with the patient in the prone position. By pulling upon the fatty capsule and by pressing on the abdomen with the hand bring the kidney into the wound and deliver it on to the back, where it may be palpated and inspected thoroughly. Should it be impossible to safely deliver the organ (because of adhesions, etc.), separate it by blunt dissection from its surroundings, except, of course, at the hilus,

when its whole surface and pelvis may be palpated. Should the presence of calculi be suspected but not be determined by palpation, it is often advised to perforate the organ in all directions with a fine round needle (lady's hat-pin). Whenever the needle touches a calculus, a sensation of grating is communicated to the hand. Should a cyst of the kidney be discovered, its contents may be obtained for examination by means of the exploring needle and syringe.

The above exploration of the kidney often fails to give the information desired, and further investigation necessitates nephrotomy.

Nephrotomy.—*Step* 1.—Expose and isolate the kidney as in the operation of exploration.

Step 2.—Deliver the kidney on to the patient's back. Surround the hilus or pedicle with a rather fine rubber band or tube not too tightly applied, and fastened by tape and forceps, as shown in Fig. 408. This renders the next step practically bloodless, but entirely prevents exploration of the ureters. Instead of using the rubber constrictor, an assistant may control the circulation with finger pressure applied to the hilus, or no control of the circulation may be attempted. In some cases it is impossible to deliver the kidney safely. Under these circumstances hook the fingers in front of the organ and bring its convex margin as well as possible into the wound.

FIG. 409.—(*Monod and Vanverts.*)

Step 3.—Grasp the kidney between the fingers and thumb of the left hand and make a longitudinal cut along its convex border of such size and depth that the finger may be passed into the renal pelvis. If necessary, the kidney may be split open

throughout its whole length, as is done at the postmortem table (Fig. 409). Introduce the finger through the wound and palpate the interior of the kidney and its pelvis; the fingers of the other hand applied to the surface of the organ aid this exploration. If the elastic constrictor has not been employed or after its removal, the ureters may be examined by ureteral catheters or bougies passed through the wound. To obviate this trouble it is proper to apply the constrictor to the vessels alone. When the active examination or operation is completed, close the renal wound with a few catgut sutures introduced by a round needle, *i. e.*, one without cutting-edges. The sutures stop all hemorrhage.

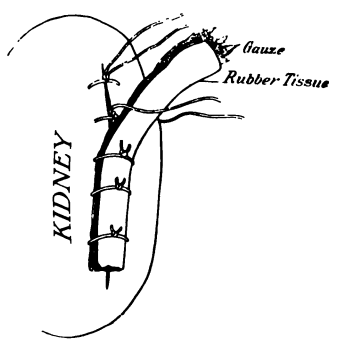


FIG. 410.

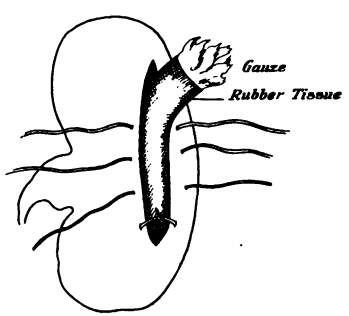


FIG. 411.

Close the lumbar wound, in layers, with buried sutures or with through-and-through sutures of silkworm-gut. Provide for drainage if necessary. This may be accomplished by placing a few layers of gauze, covered by rubber tissue, over the line of suture, and tying the ends of the catgut sutures, left long for this purpose, over the gauze (Fig. 410).

When nephrotomy is performed as a therapeutic measure, complete closure of the renal and lumbar wounds is almost always improper. Drainage must be provided. Drainage may be accomplished as follows:

(*a*) Introduce a wick of mildly iodoformized gauze, surrounded by rubber tissue (cigarette drain), into the portion of

kidney to be drained and fix it there by a stitch of plain catgut, or tie the ends of one of the renal sutures around the drain (Fig. 411). This simple precaution is perfectly harmless and prevents displacement of the drain.

(*b*) Use in the same manner a rubber tube split longitudinally and containing a wick of gauze. The split runs the whole length of the tube, diminishing its rigidity and thus avoiding some possibilities of injury to tissues from pressure. Do not insert the tube too deeply, as it may then cause much pain and even reflex anuria.

(*c*) In the same manner use and fix in place a dressed rubber tube (Fig. 412).

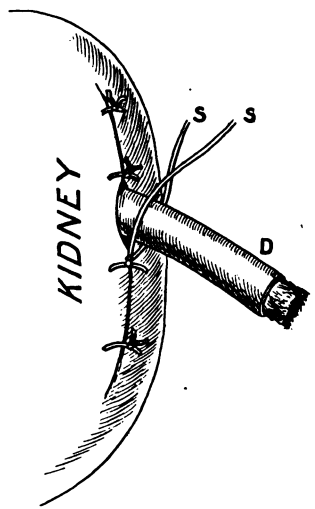


FIG. 412.

If the kidney is the seat of multiple abscess and nephrectomy is not indicated, open all the abscesses freely, either through the original renal incision or through individual incisions, as may be convenient. If it is believed that relief of tension may be of value in a case where nephrotomy has revealed no pathological condition sufficient to account for the symptoms, then it is wise to leave the renal wound at least partly open. A. H. Ferguson, Edebohls, and others practise decortication of the kidney when they desire to relieve tension in cases of nephritis. Their operation for nephritis consists in exposure, delivery, and decortication of the kidney. Excellent reports have been published as to the success of decortication in nephritis, but the whole question is still *sub judice*. Wounds of the kidney heal rapidly when sutured.

Nephrolithotomy.—Expose and if possible deliver the kid-

ney as in nephrotomy. Control the renal circulation by finger pressure at the hilus or by the elastic constrictor, if this is feasible. Incise the kidney as in nephrotomy. If the stone is small and lies free in the pelvis, pass a forceps through the renal wound and extract it. When the stone is large and fills the renal calices, its extraction becomes a matter of great difficulty. Under such circumstances enlarge the incision through the kidney to the necessary extent. With the finger, peel the stone out of the calices and remove it unbroken. If its removal entire is impossible, fracture it with forceps, but let the fragments be as few in number as possible. If there are many and small fragments, some of them are liable to escape extraction and cause trouble in the future. Remove all débris with finger, spoon, forceps, gauze strips, or douche. When several calculi are present, they may often be extracted through the same renal wound, but if more convenient, they may be removed through separate incisions. It is far less damaging to the kidney to make several clean incisions through its parenchyma, and thus extract the calculi with the minimum of laceration and contusion, than to endeavor to take them all out through one cut. The latter plan too often results in the kidney being converted into a ragged mass lying inside a nearly perfect capsule.

The calculi having been removed, introduce and fix drains in the renal wounds, as has been described under the heading Nephrotomy. Close the nephrotomy wounds as far as necessary with catgut. Close the lumbar wound except where the drains emerge. A stone weighing four and one-half ounces has been removed in the above manner.

Pyelotomy and Pyelolithotomy.—The kidney is exposed and if possible delivered after the methods already described. The pelvis of the kidney is incised. The incision should not be located too near the renal parenchyma, for the following reasons (Israel): (1) In this location sutures are inserted with difficulty and are liable not to hold. (2) When a stone is being extracted through such a cut, the renal parenchyma may be injured, resulting in hemorrhage and subsequently renal colic

from the blood-clots formed in the pelvis and ureter. After the stone is extracted, the pelvic wound is to be closed by a few Lembert sutures unless drainage of the pelvis is demanded. Wounds of the pelvis of the kidney heal readily when infection is absent.

Comparative Advantages or Disadvantages of Pyelolithotomy and Nephrolithotomy (Rovsing).—*Pyelolithotomy.*—*Advantages:* Little hemorrhage and no injury to renal parenchyma. *Disadvantages:* Stones in the calices cannot be removed. Fistulæ are liable to result and persist.

Nephrolithotomy: By means of this procedure all stones can be removed. When no suppuration exists, the renal wound may be closed and heal *per primam.* If pus is present, the wound may be partially closed and drainage provided. Fistulæ when they occur are more readily closed than after pyelotomy. In many cases the hemorrhage which may occur is not of importance. Hemorrhage would be dangerous in patients weakened by prolonged disease or in cases where it is necessary to split the kidney throughout its whole length in order to remove a very large stone, were it not that the renal vessels may be readily controlled by the finger pressure or the elastic constrictor. The injury to the parenchyma inevitably incurred is of comparatively little importance.

Partial Nephrectomy.—Experiment and experience show that wounds of the kidney heal readily and that large parts of the normal kidney may be removed without noticeable ill effect. Tuffier's experiments seem to show that one-third or one-fourth of the kidney is sufficient for the performance of function.

The kidney is exposed and delivered through any of the incisions already described. The diseased portion of the organ is removed, if possible, by a V-shaped incision, so that the resulting wound may be easily closed by catgut sutures. This typical removal is often improper, as by it too much healthy parenchyma might have to be sacrificed. For disease involving the upper or lower ends of the kidney a transverse incision may suffice and sacrifice the least possible amount of healthy parenchyma. In the case of irregular multiple but localized abscesses,

dissection. A pedicle needle is passed between the vessels and the ureter as they enter or leave the hilus; a double ligature is pulled through as the needle is withdrawn. One ligature is tied tightly around the vessels as already described. The ligature intended for the ureter is not yet tied. The ureter is grasped by forceps. The pedicle is divided, leaving a sufficiently large stump, and the kidney is removed. The ureter is now examined. If it is clean and safe, the ligature provided for it may be tied and the ureter allowed to drop into the wound. If the ureter is infected and its cavity dilated and full of pus, it must be thoroughly cleansed both by washing and by scraping with a sharp spoon. After being cleaned, the ureter may be ligated and allowed to retract into the wound, or it may be left open and fixed to the lumbar wound by a few sutures. If the disease for which operation is performed be tuberculous and the ureter is involved, it may be followed, through the lumbar wound, down to the brim of the pelvis and excised to that extent. In any event an effort should be made to deprive the distal ureter of its mucous lining and to close the upper opening of the distal segment by inverting it.

If in non-malignant disease the kidney is so firmly adherent to its surroundings as to make removal by the usual method a matter of great difficulty, then its fibrous capsule may be opened and the kidney proper separated from its capsule and removed, leaving the fibrous capsule *in situ*. Any diseased material adhering to the capsule is to be scraped away.

The excision of a very large hydronephrotic kidney calls for manœuvres not yet considered. Israel says that observance of two rules makes the operation tolerably easy and safe: *First*, as in the case of all benign tumors, be sure to get down to the capsula propria. This is accomplished by cutting the tissues layer by layer, each layer being raised by two forceps before being cut and the cut being made between the forceps. It is surprising how many layers of more or less firm fibrous tissue are formed from the fatty capsule and must be passed before the capsula propria is reached. Having reached the capsule,

clear as large an area of its surface as is possible without evacuating its contents. *Second,* a trocar and cannula are inserted into the tumor to empty it. The cannula is provided with a long rubber tube to drain away the fluid without soiling the wound. When the tumor has collapsed, withdraw the cannula, at the *same moment* closing its puncture wound by catching up a fold of the tumor-wall (at the point of puncture) between the finger and thumb. Forceps may be used instead of the digital grasp. Pull the now flaccid tumor-wall out of the lumbar wound, separating adhesions with the flat of the fingers of the other hand as the tumor is being delivered. Tough adhesions must be divided between ligatures or forceps. These will be most common near the top of the tumor. Do not bore in or mine with the fingers around the tumor, and never endeavor to hook out the growth with the fingers. Such endeavors may tear the pedicle or even lacerate the vena cava. Everything must be done under control of the eye. When the sac is so far extracted that the region of the hilus is reached, even more care must be exercised in the separation of adhesions, as in hydronephrosis the veins are not always gathered together in a convenient pedicle, but are spread out and have many diverging branches. Operating in the above manner, every vessel may be seen and ligated.

(B) *Nephrectomy by the Abdominal Route.*—The kidney is exposed by Langenbuch's incision (page 445). The finger passed through the wound in the mesocolon (page 445) separates the kidney from its surroundings until the hilus is reached. With an aneurysm needle a double ligature is passed between the ureter and the vessels, and *the vessels* are tied in two places and divided between the ligatures. This double ligation is practised to prevent a flow of blood from the kidney which would obscure the wound. The ureter is divided between forceps. The kidney is removed. The ureter is examined, and if found clean and healthy, it is ligated and allowed to retract into the wound. The whole retroperitoneal cavity created by the removal of the tumor is examined and any bleeding point which

may have been overlooked receives attention. Oozing of blood is lessened by temporary pressure with gauze pads wrung out of hot water. Drainage may be provided through the lumbar region in the following manner: From the cavity to be drained a closed forceps is thrust backwards through the lumbar tissues, just external to the quadratus lumborum muscle, until it raises the skin on the back. The skin is incised and the point of the forceps thrust through the incision. If necessary, the opening may be enlarged. Either gauze or tubular drains may be employed, according to circumstances. The above operation appears easy *on paper*, but when the kidney is much enlarged and when it is adherent to its surroundings, the procedure is one of great difficulty. While the organ is being separated from its surroundings it may be necessary to apply many ligatures to control hemorrhage. A large cystic kidney may require to have its fluid contents aspirated before the pedicle can be treated or the tumor delivered. Of course, under such circumstances the puncture wound made by the aspirator or cannula must be closed with forceps as soon as the instrument is withdrawn. Treatment of the pedicle often presents difficulties. It may be easier to apply clamps to the vascular pedicle than ligatures. If this is done, much care must be exercised. Thornton once included a small piece of the vena cava in the forceps and lost his patient from hemorrhage. Hartmann, while enucleating a large pyonephrotic kidney, tore a hole of 3 cm. (1¼ inches) in the vena cava, below the renal vein. He immediately ligated the vena cava above and below; the patient recovered. Had the tear involved the region of the renal veins, he would have sutured the wound in the vena cava. (See also page 588.) When clamps are used, ligatures must be substituted for them as soon as the tumor is removed. Some surgeons, when possible, ligate the renal vessels before enucleating the kidney. When the ureter is septic, it must be doubly tied near the kidney and divided between the ligatures. The ligation prevents its septic contents escaping into the wound. The ureter (after the kidney is removed) is pulled outwards and fixed in the lumbar drainage wound. Lumbar drainage

having been provided, the abdominal wound can be completely closed. Many surgeons advocate careful suture of the wound made through the outer layer of the mesocolon so as to close the peritoneal cavity. This is generally considered unessential.

Remarks.—Exploration is indicated in cases where it is believed that the kidney has been ruptured and that extravasation of urine or blood is taking place. Any lacerations found must be closed by suture. If mere suturing is insufficient to stop the hemorrhage, or if the trauma has destroyed much renal parenchyma, the wound in the kidney should be packed with gauze held in place by plain catgut sutures (Fig. 411). Even when the wound has been closed by sutures it is often wise to lay a strip of gauze along the line of suture and fix it, by tying over it the ends of the sutures, which have been left long for this purpose (Fig. 410). The gauze used should be covered with rubber tissue where not in contact with the kidney; this prevents the drain becoming adherent to surrounding structures.

Ransohoff promulgates the following theses regarding renal tuberculosis where operation is indicated: "(1) When the operation reveals a strictly localized lesion, a partial excision or curettage should be done.* (2) Nephrotomy is indicated when uncertainty exists as to the condition of the opposite kidney or for the temporary relief of an acute sepsis, and when the condition of the patient will not permit the major operation. It is then to be followed as speedily as possible by nephrectomy. (3) Unless unusual conditions call for nephrotomy, it is not to be advocated for renal tuberculosis. It may even do harm by autoinfection. (4) Primary nephrectomy should be considered the normal procedure for renal tuberculosis when an operation is at all indicated."

The presence of a renal calculus always calls for operation. The danger of the condition and especially of the operation is

*The author has mistaken an apparently well-encapsulated hypernephroma for a localized tuberculous lesion, performed partial excision, and obtained a disastrous result. This error is easily made, and should be remembered.

not so much due directly to the stone as to infection. This seems a truism, but in renal and biliary surgery physicians and patients are far too prone to delay interference until such becomes distinctly, if not very, dangerous. The same reasons which make early operation safe in cases of appendicitis call for early operation in renal calculus, although in the latter a moderate amount of delay does not lead to such disastrous results.

Pyonephrosis or surgical kidney demands operation. If the disease is so severe that drainage will put too great a strain on the patient's recuperative powers; if the other kidney is in such health that it can be depended upon for elimination, and if the immediate condition of the patient permits nephrectomy, then nephrectomy is the operation of choice. When doubt exists as to the functional ability of the other kidney, or when the general condition of the patient contraindicates the more severe operation, drainage is the operation of choice. The same is true in calculus disease when infection is present. If in the above diseases the inflammatory process is moderate and a useful amount of renal parenchyma remains intact, drainage gives excellent results, or partial nephrectomy plus drainage may be the better procedure to adopt.

Anuria, especially calculous anuria, calls for nephrotomy, and, as Morris points out, the operation ought to be on the kidney which appears to have become last affected, *i. e.*, on the organ which presumably is in the better condition. Anuria following nephrectomy calls for immediate nephrotomy on the remaining kidney. (Willy Meyer.)

Harrison demonstrated long ago that operations undertaken for calculi proved in many instances curative, even when no calculi were found, and he concluded that nephrotomy might be a reliable therapeutic agent in certain cases of acute nephritis by relieving renal tension. A. H. Ferguson, Edebohls, and others believe that by decortication of the kidney a cure (symptomatic at least) may be obtained in chronic interstitial nephritis. At present this subject is distinctly *sub judice*, but very remarkable results have been claimed by thoroughly reliable men.

CHAPTER II.

OPERATIONS ON THE URETER.*

Anatomy.—The ureters conduct the urine from the kidneys to the base of the bladder, the walls of which they pierce obliquely, thus providing themselves with valvular outlets. The average length of the ureter is 12 inches; its narrowest point is about 2½ inches below the hilum of the kidney (diameter here about ⅛ inch), and the next narrowest point is at the brim of the pelvis. Calculi are liable to become caught at these two places and at the point where the bladder is entered. The ureters are lined by a thin mucosa which is thrown into folds. A thick muscular and a thin but elastic external fibrous tunic completes the ureteral wall.

The ureter lies loosely in the post-peritoneal connective tissue. "In the abdominal portion of its extent it lies upon the front of the psoas muscle, and about half-way between its commencement and the brim of the pelvis, or somewhere below that point, it crosses in front of the genito-crural nerve. The upper half of this portion of the duct, except at its commencement on the right side, where it is covered by the third part of the duodenum, is in direct contact with the peritoneum, to which it is intimately connected; and the lower half is separated from the peritoneum by the spermatic or ovarian vessels, which are, however, closely united both to the ureter and to the serous membrane. . . . . At the brim of the pelvis the relation of the ureter to the large vessels is not always quite the same, as it may rest either upon the lower end of the common iliac artery or upon the external iliac; it is covered in front by the peritoneum and it is crossed on the right side by the termination of the ileum, and on the left

*In this chapter very free use has been made of Morris' work on "Surgical Diseases of the Ureter and Kidney."

by the commencement of the rectum." (Morris, "Surgery of the Kidney and Ureter.")

Tourneur's point corresponds approximately to the upper end of the ureter and the level of origin of the spermatic or ovarian artery. Draw a transverse line from the tip of one twelfth rib to that of the other. Draw a vertical line upwards from the junction of the middle and inner thirds of Poupart's ligament. Where these two lines cross is Tourneur's point.

To find where the ureter crosses the iliac artery, Morris gives the following advice: For practical purposes, a point lying at the junction of the upper and middle thirds of the line indicating the course of the common and external iliac arteries will sufficiently indicate its position. The line marking the course of the iliac vessels is drawn from the bifurcation of the aorta, half an inch below and to the left of the umbilicus, to midway between the anterior superior spine of the ilium and the symphysis pubis.

Hydronephrosis is commonly the result of ureteral obstruction, whether due to calculus, stricture, external pressure, or torsion of the tube from renal ptosis. Of course, the cause must be sought and, if possible, removed.

It is important to note the relationship between the ureter and the pelvis of the kidney. Normally the ureter opens into the lowest point in the pelvis, but in hydronephrosis the opening may be high up on the pelvic wall, and hence escape of fluid from the kidney becomes impossible even if the original obstruction of the ureter is remedied. Various operations have been devised for the correction of the faulty relation between ureter and renal pelvis.

Mynter's Method.—Expose and explore the kidney and its pelvis. Make an incision into and explore the interior of the greatly dilated pelvis or the hydronephrotic sac. If possible, pass a catheter through the ureter down to the bladder and find if ureteral stenosis exists. If the opening of the ureter is high up on the side of the sac (Fig. 413), make the incision A, B, through the wall of the sac, parallel and opposite to the ureter. Make the similar incision A, C, in the ureter. Unite the anterior edge of

the ureteral wound to the anterior edge of the sac wound (x–x¹, Fig. 414). Unite the posterior edge of the ureteral wound to the corresponding edge of the sac wound (y–y¹). The sutures, of

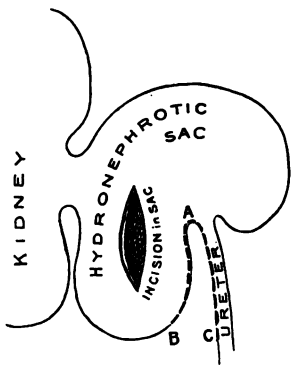


FIG. 413.

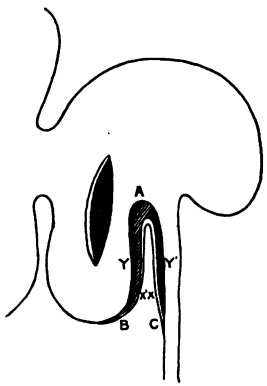


FIG. 414.

fine silk or hemp, must not include the mucosa in their bite. (This lest calculi form on them.) The result is a lowering of the ureteral orifice to the lowest point in the sac. The operation is identical in principle with Mikulicz's pyloroplasty (Fig. 415). If a ureteral stricture exists between the points A and C, the operation of course cures that also. When obstruction is due to kinking of the ureter over one of the renal vessels, either make an anastomosis between the sac and the ureter below the obstruction (Fig. 416, x–y) or divide the ureter and unite the open end of the lower segment to the lowest point in the hydronephrotic sac.

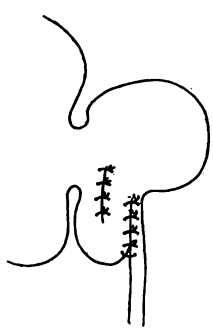


FIG. 415.

Küster ("Archiv f. klin. Chir.," xliv, 850) describes a case where the above operations were impracticable, as an impermeable stricture of the ureter existed a short distance below the sac. He divided the

ureter immediately below the stricture, separated it sufficiently from its surroundings so that it could be brought up to the sac without tension; split the upper end of the ureter (Fig. 417); make an incision through the posterior wall of the sac at its lowest level; spread open the split upper end of the ureter and sutured it to the vivified internal surface of the anterior wall of the sac (Fig. 418). The ureter was thus formed into a sort of funnel opening into the sac. The wound in the sac was closed with sutures (Fig. 419). The result was good. Israel has lessened the size of the distended pelvis by a plication of its walls similar to that practised for the cure of dilatation of the stomach. Occasionally in hydronephrosis a valve is present at the uretero-pelvic junction, which prevents the complete evacuation of the renal pelvis or hydronephrotic sac. Fenger's operation for this condition is as follows: Expose the kidney. Open the renal pelvis and examine the interior, espe-

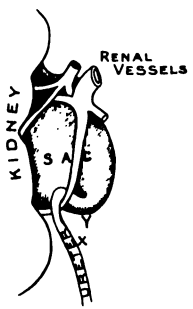


FIG. 416.—(*Modified from Morris,*)

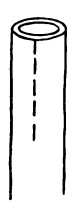


FIG. 417.

FIG. 418.

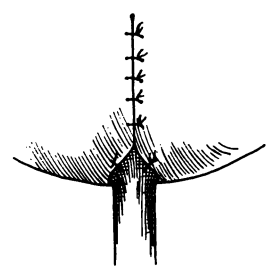


FIG. 419.

cially the ureteral opening. Pass a bougie into the ureter. Excise the valve by a transverse incision (Fig. 420, A B). Close with fine catgut sutures the wound left by the incision of the valve. Close the wound in the sac.

When hydronephrosis is due to or kept up by a stricture at the junction of the ureter and pelvis, the operation practised by Fenger was the following: Make the incision A, a (Fig. 421), through the stricture and continue for a short distance upwards through the sac-wall and downwards through the ureteral wall. With sutures unite the points A, a; B, b; C, c, etc. This practically amounts to an anastomosis between the ureter and the renal pelvis. To avoid tension it may be necessary to separate the ureter from its surroundings for a short distance.

Exposure of the Ureter.—(A) *Transperitoneal Route.*—The ureter can be reached through a median or lateral abdominal incision. This method is occasionally valuable as a means of

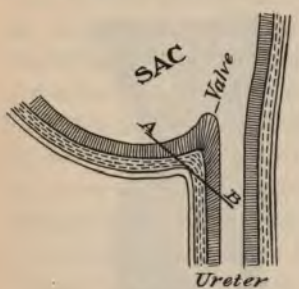


FIG. 420.

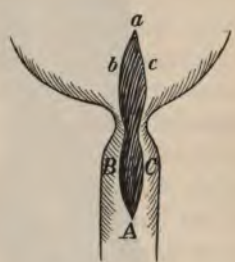


FIG. 421.

diagnosis, permitting, as it does, palpation of the opposite kidney, and the recognition of stones impacted in the ureter and of other conditions. As a step in such operations as uretero-lithotomy the method has little scope of usefulness, the dangers from peritoneal infection being very evident. In operations such as uretero-ureterostomy and uretero-cystostomy, etc., the transperitoneal route is of great value.

(B) *Extraperitoneal Routes.*—I. *Lumbo-ilio-inguinal route* (Morris): By this route the ureter may be explored throughout its whole length. (*a*) Exploration of lumbar portion of ureter. Place the patient lying on his healthy side with the abdomen turned somewhat towards the table. Do *not* place any pillow under the opposite loin. Beginning at the outer edge of the

sacro-lumbar mass of muscles, a little below the twelfth rib, make an incision obliquely forwards and downwards to a point one inch internal to the anterior superior spine of the ilium. Continue the incision parallel to and one inch above Poupart's ligament, as far as its centre (Figs. 422 and 423). *Cut down to, but not through,* the peritoneum. Expose the kidney. Palpate the renal pelvis between finger and thumb. By exercising slight traction on the pelvis the ureter may be made more prominent. With the fingers or a pledget of gauze strip the peritoneum from the parietes until the ureter is seen. "The relation of the ureter to that part of the peritoneum which is adherent to the spine is rather constant, the ureter being situated just external to the line

Fig. 422.

Fig. 423.

FIGS. 422 AND 423.—(*Monod and Vanverts.*)

of adhesion. Therefore, when the operator has stripped up the peritoneum and reached this point, he will find the ureter on the stripped-up peritoneum external to it." (Kelly.) Remember that the ureter adheres to the peritoneum even when that membrane is raised from the subjacent structures. A little tension exercised on the renal pelvis helps to render the ureter recognizable.

(*b*) Exploration of pelvic portion of ureter. Roll the patient over so that while still resting on his sound side his back, instead of his abdomen, is turned somewhat towards the table. Enlarge the wound, if necessary, forwards, "even as far as the ex-

ternal abdominal ring" (Morris), always carefully avoiding opening the peritoneum. Should the peritoneum be opened by accident, close it at once with sutures. Sometimes the kidney is not available as a guide to the ureter and one is forced to hunt for that tube at the pelvic brim. Here the guide to the ureter is the place where it crosses the iliac artery, and when the peritoneum is stripped off, it will be found adhering to that membrane "like a whitish or yellowish white tape." In the male the ureter may be examined in this manner down to the bladder, but in the female it runs in the broad ligament, which makes it very difficult of access. The uterine artery lies in front, the veins behind, the ureter.

II. *The sacral route:* Morris thus describes Delbet's operation: "(1) The patient should be placed upon his sound side, so that the rectum may fall away from the wound. (2) The incision should be **L**-shaped, with the long arm vertical, along the border of the coccyx, and the short falling upon the superior extremity of the first, being almost parallel to the fibres of the gluteus maximus. (3) Cut the insertion of this muscle and the sacro-sciatic ligaments and some fibres of the pyriformis. (4) Lay bare the lateral face of the rectum with forceps and a director. The ureter is always to be found adherent to the detached peritoneum, and can be followed downwards to the bladder and upwards for seven or eight cm. from its termination. This description applies specially to man; in woman the operation is more difficult because of the broad ligament."

Various surgeons have used modifications of Kraske's sacral operation to gain access to the ureter, but these have little to recommend them.

(C) *Perineal Route.*—An operation through the perineum, very similar to that used for the exposure of the prostate by a curved transverse incision, permits the exposure of the seminal vesicles, and with them the lower end of the ureter.

(D, E) *Vaginal and Rectal Routes.*—Ureteral calculi palpated through the vagina or rectum have been successfully removed by direct incision through the walls of these cavities. The wounds were sutured immediately.

(F) *Transvesical Route.*—Calculi impacted at the vesical orifice of the ureter may be reached and removed by suprapubic or perineal cystotomy. Young and Bransford Lewis have successfully removed calculi in this position by means of the cystoscope.

Ureterotomy and Uretero-lithotomy.—Expose the ureter by one of the extraperitoneal methods. Introduce into it, if possible, two catgut sutures (X–X¹, Y–Y¹, Fig. 424), each of which is in the long axis of the ureter. Using the sutures to fix the tubes, make a longitudinal incision into the ureter, over the calculus, if such is present. It is wise when possible to push the stone up the ureter, incising at this new point lest ulceration at the site of impaction interfere with healing. Remove the calculus or

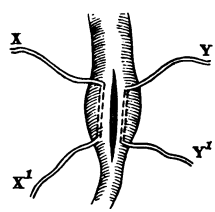


FIG. 424.

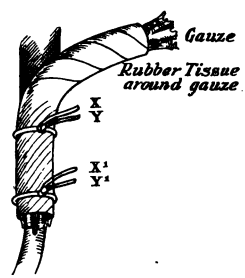


FIG. 425.

explore the ureter as may be indicated. Apply a long strip of iodoform gauze over the ureteral wound between the two sutures. Cover the exposed surface of the gauze, opposite its line of contact with the ureter, with rubber tissue. Tie the end of the suture X over the gauze to Y, and the end of the suture X¹, similarly to Y¹ (Fig. 425). Envelop in rubber tissue the remainder of the strip of gauze (*i. e.*, the portion not in contact with the ureter), and bring it out of the wound in the parietes. Close the parietal wound except where the drain emerges. This closes the ureteral wound efficiently and safely.

Many surgeons suture the wound in the ureter with a few fine silk or hemp stitches which do not involve the muco[illegible] other

surgeons omit all suture of the ureteral wound, trusting to nature to close the wound. On the whole, the first method described appears the best. When drainage of the ureter is desired, one may act as follows:

Trim in the fish-tail fashion the end of an appropriate sized rubber tube; wrap around the tube a few layers of gauze; cover the gauze with rubber tissue. Leave about ¼ inch of the "fish-tail" end of the tube free from gauze. Perform the ureterotomy, using catgut sutures as handles (Fig. 426). Introduce the bared end of the dressed tube into the ureter. With a needle stitch sutures X–X¹ and Y–Y¹ to the tube; this holds the drain in place.

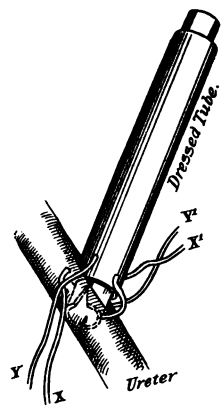


FIG. 426.

Ureterotomy for the cure of ureteral stricture is performed as follows (Fenger's operation):

Expose the ureter by the extraperitoneal route. Make a longitudinal incision into the ureter immediately above the stricture; pass a suitable probe or bougie through the stricture; continue the vertical incision through the

FIG. 427.

FIG. 428.

FIG. 429.

stricture and downwards until the wound below the site of stricture is equal in length to that above (Fig. 427). With sutures unite the point A to A¹, B to B¹, etc. (Fig. 428). The result

(F) *Transvesical Route.*—Calculi impacted at the vesical orifice of the ureter may be reached and removed by suprapubic or perineal cystotomy. Young and Bransford Lewis have successfully removed calculi in this position by means of the cystoscope.

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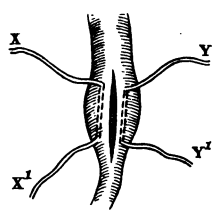

FIG. 424.

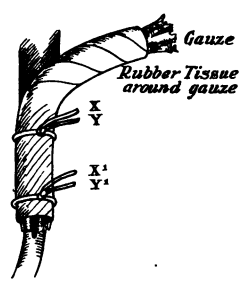

FIG. 425.

explore the ureter as may be indicated. Apply a long strip of iodoform gauze over the ureteral wound between the two sutures. Cover the exposed surface of the gauze, opposite its line of contact with the ureter, with rubber tissue. Tie the end of the suture X over the gauze to Y, and the end of the suture X¹, similarly to Y¹ (Fig. 425). Envelop in rubber tissue the remainder of the strip of gauze (*i. e.*, the portion not in contact with the ureter), and bring it out of the wound in the parietes. Close the parietal wound except where the drain emerges. This closes the ureteral wound efficiently and safely.

Many surgeons suture the wound in the ureter with a few fine silk or hemp stitches which do not involve the mucosa; other

surgeons omit all suture of the ureteral wound, trusting to nature to close the wound. On the whole, the first method described appears the best. When drainage of the ureter is desired, one may act as follows:

Trim in the fish-tail fashion the end of an appropriate sized rubber tube; wrap around the tube a few layers of gauze; cover the gauze with rubber tissue. Leave about ¼ inch of the "fish-tail" end of the tube free from gauze. Perform the ureterotomy, using catgut sutures as handles (Fig. 426). Introduce the bared end of the dressed tube into the ureter. With a needle stitch sutures X–X¹ and Y–Y¹ to the tube; this holds the drain in place.

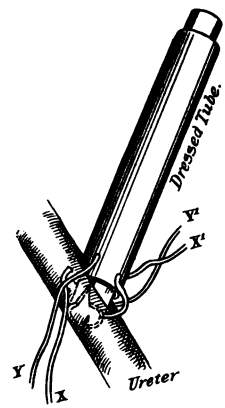

FIG. 426.

Ureterotomy for the cure of ureteral stricture is performed as follows (Fenger's operation):

Expose the ureter by the extraperitoneal route. Make a longitudinal incision into the ureter immediately above the stricture; pass a suitable probe or bougie through the stricture; continue the vertical incision through the

FIG. 427.

FIG. 428.

FIG. 429.

stricture and downwards until the wound below the site of stricture is equal in length to that above (Fig. 427). With sutures unite the point A to A¹, B to B¹, etc. (Fig. 428). The result

is practically the formation of an anastomosis (Fig. 429) between the upper and lower segments of the tube. Close the external wound after providing for drainage.

Ureterectomy.—Ureterectomy may be carried out as a step in the operation of nephrectomy or as a secondary operation. The ureter is exposed extraperitoneally by the lumbo-ilio-inguinal incision. It is not always necessary to make the external incision continuous throughout the whole length described on page 469. After the kidney is delivered or removed the ureter may be followed, by a burrowing dissection, down towards the pelvis, a

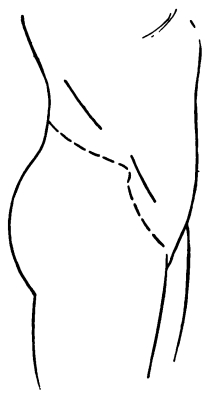

FIG. 430.

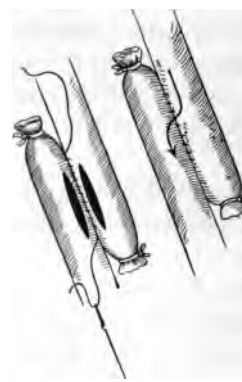

FIG. 431.

forceps or stout probe passed down to the bottom of the wound to act as a guide, while a second incision is made through the parietes (Fig. 430). No special description of technique is required. Note that an apparently tuberculous ulceration of the vesical mucosa near the mouth of the ureter is not a contraindication to nephrectomy and ureterectomy. When the diseased kidney and ureter are removed, the vesical lesion frequently recovers spontaneously.

Ureteral Anastomosis.—(A) *Monari's Method: Lateral Anastomosis.*—This operation is practically the same as lateral anastomosis of the intestine Fig. 431 sufficiently explains the method, which is in every way inferior to the Van Hook operation.

(B) *Van Hook's Operation: Lateral Implantation.*—Split the upper segment of ureter for a short distance. This is important, as it prevents stenosis at the orifice (Fig. 432). Ligate the upper end of the lower segment of ureter. Pass the fine catgut suture X Y through the lower wall of the upper segment opposite the split described above (Fig. 432). Make a vertical incision into the lower segment immediately below the site of ligation. With round needles (either straight or curved) pass the suture X Y through the opening in the ureter and make its ends emerge at the points O.N. (Fig. 433). As catgut is not easily threaded in fine needles, one may arm the needles with a suture carrier of silk or hemp, by which means the introduction of the catgut becomes easy (Fig. 434). Insert the lower end of the upper segment of ureter through the wound in the lower segment, pull the suture X Y sufficiently tight, and tie it (Fig. 435).

FIG. 432.

Whenever possible, the extraperitoneal route should be chosen in performing uretero-ureterostomy.

FIG. 433.

Uretero-cystostomy.—This operation is called for in certain cases of persistent ureteral fistula, in cases where part of the ureter has been destroyed in the course of operations, *e. g.*, on the uterus. It takes the place of removal of the corresponding kidney, and where feasible is the operation of choice.

(A) *Vaginal Route.*—When done to cure a uretero-vaginal fistula, the operation consists essentially in freeing the lower end of the ureter from its surroundings and in suturing it into a small opening in the bladder. When freeing the ureter, a bougie or probe passed into it is a most

valuable aid. The method of uniting the duct to the bladder will be described in the succeeding pages.

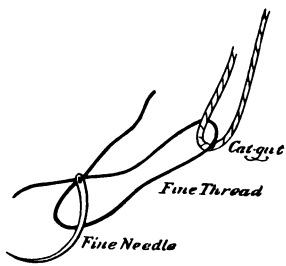

FIG. 434.

(B) *Superior Extraperitoneal Route.*—Expose the ureter by the lumbo-ilio-inguinal incision or a modification thereof. This is much less difficult to accomplish in the male than in the female, so far as the pelvic segment of the ureter is concerned; the broad ligament interferes considerably in the female.

(C) *Transperitoneal Route with Extraperitoneal Ureterocystostomy* (Witzel's Operation).—Open the abdomen by a median incision in the hypogastrium. Incise the peritoneum over the iliac vessels; separate the peritoneum from the subjacent structures by blunt dissection. The ureter will be found united to the peritoneum and elevated with it. Make slight upward traction on the ureter to make it prominent and recognizable low down, in the broad ligament. By a second incision in the broad ligament expose the ureter; divide it; ligate and cauterize the opening in the lower segment. Pull the upper segment up to and out of the original incision over the iliac vessels. With a long forceps guided behind the peritoneum to the side of the vesical region "above the linea innominata," through this tunnel under the peritoneum, draw the ureter down, and anastomose it to the bladder extraperitoneally. Close the two small wounds in the peritoneum. To make the anastomosis without tension on the line of suture Witzel pulled the bladder towards

FIG. 435.

the ureter and fixed it there, to the posterior parietes at the line of peritoneal incision.

(D) *Intraperitoneal Route.*—This method has been used successfully in a number of cases and seems to be the method of choice when uretero-cystostomy is undertaken in the course of an abdominal operation in which the ureter has been divided. The end of the upper segment of the ureter must be found, if necessary in the manner described in Witzel's operation, and sufficient of it separated from its surroundings to permit its approximation to the bladder, without tension. To aid in this approximation Witzel's plan of suturing the bladder to the side of the pelvis may be useful, but Kelly's procedure is better. Kelly detaches the bladder from the horizontal rami of the pubes and thus can bring the bladder to the ureter.

Methods of Uniting the Ureter to the Bladder.—(A) Pass a forceps through the urethra into the bladder and push its point against the bladder-wall at the place where it is desired to make the anastomosis. At this point incise the bladder. The ureter has already been prepared and has a long suture penetrating its wall. Catch the ends of this suture in the forceps and pull them into the bladder and out through the urethra (in the male the urethra may be opened in the perineum for the passage of the forceps; in the female, the urethra serves). Traction on the suture pulls the open end of the ureter into the bladder and keeps it there temporarily. To prevent contraction of the open end of the urethra either cut it obliquely or split it as in the Van Hook operation for anastomosis. Carefully suture, with several tiers of suture, the outer coats of the bladder to the outer coats of the ureter in the Lembert fashion.

(B) This method is similar to the above, but a ureteral catheter is used in place of the forceps. Pass a ureteral catheter through the urethra into the bladder and bring its end out through an incision in the bladder at the site of anastomosis. Introduce the end of the catheter into the end of the ureter and tie it there with a fine plain catgut ligature (Fig. 436). Aided by traction on the catheter pull the end of the ureter into the bladder and fix it there

by several layers of sutures introduced after the Lembert fashion. The ureteral catheter serves to drain the ureter and hold it in position until union takes place.

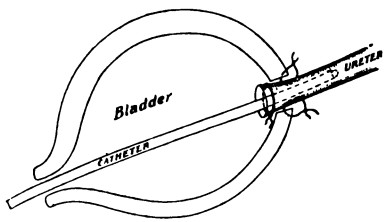

FIG. 436.

(C) *Van Hook Method.*—The end of the ureter is split to prevent subsequent stenosis. The operation is practically the same as in the case of uretero-ureterostomy, except that a line of Lembert sutures, burying the site of anastomosis and the one stitch which penetrates all the coats of the bladder, adds much security (Figs. 437, 438).

Implantation of the ureter into the intestine, preferably into the sigmoid, is carried out in the same fashion as into the bladder, but the results have uniformly proved disastrous, as infection invariably passes up the duct to the kidney. Von Maydl's implantation of the ureters, plus a portion of adjacent bladder-wall, into the sigmoid does not belong to the same category and gives good results. It will be described in another chapter.

FIG. 437.

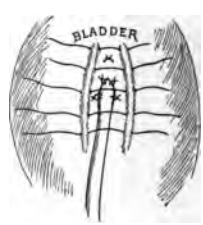

FIG. 438.

Union of the ureter to the skin is occasionally necessary, but the results are bad. Infection gains access to the tube and so to the kidney. The operation has its field of usefulness, however. When operating, *e. g.*, on a cancerous uterus, the ureter may be accidentally or intentionally divided; the condition of the patient may not admit of uretero-ureterostomy or uretero-cystostomy. Under such circumstances it may be the best policy to fix the ureter to the skin and subsequently perform uretero-cystostomy.

It has been suggested that in all cases of ureteral anastomosis success is promoted if the corresponding kidney is exposed posteriorly, fixed to the lumbar region, and drained through a nephrotomy wound.

CHAPTER III.

OPERATIONS ON THE BLADDER.

ECTOPIA VESICÆ (EXSTROPHY OF BLADDER).

Exstrophy of the bladder may be complete or incomplete. When incomplete, the case is usually one of non-obliterated urachus, and urine escapes from the umbilicus. This may be due to some mechanical obstacle to normal urination, and treatment must be directed primarily to removal of such obstacle (*e. g.*, phimosis). If spontaneous closure of the fistula at the umbilicus does not occur, the passage may be obliterated by application of the cautery or by excision.

Complete exstrophy of the bladder is a condition in which the anterior vesical wall and a corresponding portion of the parietes are absent. The anterior surface of the posterior vesical wall pouts forwards and the urine escapes at once as it leaves the ureters. As a part of the maldevelopment, one finds the pubic bones ununited and the penis in a condition of epispadias.

Operations for the relief of ectopia vesicæ may be divided into five classes:

I. The formation of an anterior wall to the bladder by means of cutaneous flaps, the epidermal side being turned inwards to provide an epithelial lining for the viscus.

II. Union of the edges of the defect, thus providing a small cavity, but one lined by bladder mucosa.

III. Formation of an anterior wall to the bladder from a segregated loop of intestine, thus providing a mucous instead of an epidermal lining.

IV. Excision of all the exposed bladder and transplantation of the ureters into the penile gutter.

V. Transplantation of the ureters into the intestine and excision of the bladder.

I. Wood's Operation for Ectopia Vesicæ.—Object of operation is to provide an anterior wall to the bladder and that such wall be lined with epithelium.

The Operation.—Flap A (Fig. 439) is made from the skin of the abdomen above the ectopic bladder and has its base near the bladder. In dissecting the flap from the subjacent tissues care must be taken to stop the dissection *at least* ¼ inch away from the edge of the bladder—*i. e.*, the hinge of flap A should be at least ¼ inch distant from the defect to be covered. The size of flap A should be greater than the defect to be covered. This is to allow for the shrinkage which always takes place in the flap. If it is desired to cover the dorsum of the penile groove with the same flap, then flap A may be extended upwards (D, the portion D of flap A D being used for this purpose). (Greig Smith.) Flaps B and C are obtained from the skin of the abdominal wall to the side of the bladder and of flap A.

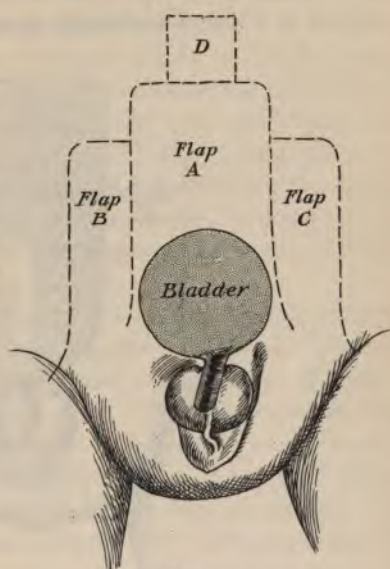

FIG. 439.

The margins of the bladder are freshened by dissection except along the edge opposite the hinge of flap A, and where the penile groove or gutter enters the bladder. Flap A is turned downwards, the line being the hinge or line of turning, so that the epithelial surface faces the bladder and the raw surface is external. The edge of the flap is stitched to the freshened edge

of the bladder. Special care must be taken in suturing the lateral margins near the base of the flap, otherwise union does not take place. Flap C is dissected from the subjacent tissues and slid over the raw surface of flap A on one side (Fig. 440). The same is done with flap B. Both are sutured in position. The extensive raw surface left on the abdominal wall by the removal of flaps A, B, and C is diminished by sliding inwards the surrounding skin, and the remainder is covered by Thiersch's skin-grafts. If the extension D of flap A has been provided, then its edges are stitched to a line of freshening on each side of the penile gutter.

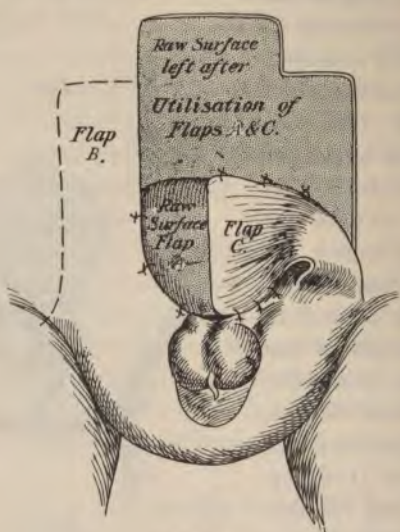

FIG 440.

II. Trendelenburg's Operation.—Note, in cases of exstrophy, the pubic bones are not united at the symphysis. This want of union prevents immediate closure of the defect in the bladder and urethra. Trendelenburg overcomes the above difficulty as follows:

Make an incision about three inches in length over each sacro-iliac synchondrosis. Open these joints and divide their

ligaments and the interarticular cartilages. Press the anterior superior iliac spines together, so that the pubic defect is obliterated or lessened. Suture and dress the sacro-iliac wounds. Keep the pubic bones in apposition by means of suitable binders applied to the anterior borders of the pelvis. After the wounds have thoroughly healed, the exposed surface of the bladder may be seen lying at the bottom of a more or less vertical groove, and may now have its edges freshened, mobilized, and united by sutures in the middle line.

This operation has given some excellent results.

Schlange's Operation.—Schlange makes an incision along the outer edge of the lower part of each rectus muscle and loosens the muscle from its surroundings. He then, with chisel and mallet, divides the bony insertion of the muscle from the rest of the pubis and slides the mobilized insertion towards the middle line, where he fixes it. The mobilization of the recti muscles permits of the approximation of the edges of the bladder and their union after freshening.

König ("Lehrbuch," ii, 634) has twice endeavored to close the pubic and vesical defects by one operation. He says: "I divided the horizontal and descending rami of the pubis through a small wound over the foramen ovale. This permitted closure of the defect in the symphysis when pressure was exerted on the pubis. The margins of the bladder and of the urethral groove were now freshened and sutured by two lines of stitches. Unfortunately, both patients succumbed." The principle of König's procedure seems admirable and its danger does not appear to the author to be intrinsically greater than that of some of the other methods the ultimate results of which are by no means brilliant.

Segond's Operation.—*Step* 1.—Make the incisions AB, DC, BC, around the ectopic bladder. The points A and D must not be at a lower level than the mouths of the ureters. Freshen the edges of the penile groove, E and F (Fig. 441).

Step 2.—Dissect the ectopic bladder downwards as a flap. The dissection must not be carried below the level of the ureteral mouths.

Step 3.—Turn the bladder flap downwards and suture its edges to the corresponding sides of the penile groove (Fig. 442).

Step 4.—Make a transverse incision through the base of the malformed foreskin (Fig. 442, X). By making the glans penis pass through the hole in the foreskin the latter is brought on to the dorsum of the penis and its tissue can be used to cover the raw surface on the back of the new-formed dorsum of the penis.

III. Rutkowski's Operation.—Rutkowski's operation and the similar one of Mikulicz have been used with more or less success in the treatment of exstrophy. They will be found sufficiently described in the pages devoted to repair of defects in the bladder-wall.

FIG. 441.

IV. Sonnenburg, in a case in which the exposed vesical mucosa protruded greatly and in which no urinal could be used, operated in the following manner: Make an incision all around the exposed mucous membrane, and through this cut dissect the mucosa from the abdominal parietes, but do *not* injure the peritoneum. Remove the mucosa completely. Dissect the lower ends of the ureters from the surrounding structures sufficiently to permit their implantation into the upper end of the gutter, which represents the urethra, and fix them there with sutures. Close

the defect left in the abdominal wall by flaps slid over from its sides.

V. Maydl's Operation.—Excise all the exposed vesical mucosa except that portion immediately around the orifices of the ureters (Fig. 443). Carefully cleanse the whole field of operation after the excision of the filthy mucous membrane. Open the abdomen. Find the sigmoid and bring a loop of it out of the wound. By stripping, empty the gut of its contents. Apply an intestinal clamp or tape above and below the part selected for anastomosis. Incise the gut longitudinally. With through-and-through sutures unite the edges of the portion of bladder-wall attached to the ureters to the edges of the wound in the sigmoid (Fig. 444 and Fig. 445). Cover this line of suture by a line of continuous Lembert sutures. The result is that the remnant or ellipse of bladder-wall is inserted like a patch into the incision in the sigmoid. Note that no great separation of the lower ends of the ureters from their surroundings is required; the loop of sigmoid is brought down to the ureteral portion of bladder, which is, of course, mobilized. The implantation of the segment of bladder-wall containing the ureters, instead of the implantation of the ureters themselves, is the important principle in the operation; by it the normal ureteral valves or sphincters are retained and infection is prevented from ascending the ureters. Several modi-

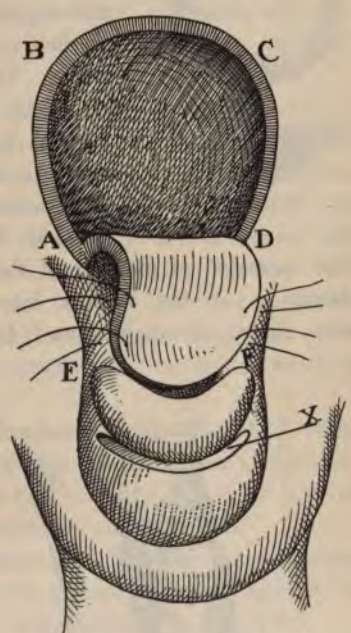

FIG. 442.—(*Farabeuf.*)

fications of Maydl's operation have been suggested, but most of them merely complicate the technique.

Remarks.—The great objection to all operations which endeavor to reconstruct the bladder, whether by the use of skin-flaps, by the union of the edges of the imperfect viscus, or by the implantation of a segregated loop of intestine, is that the result is merely the formation of a urinary receptacle which is devoid of any sphincter and hence cannot retain the urine. The only advantages to be obtained by such operations are the protection of the vesical mucosa from injury and the direction of the urine towards the penile gutter, where it is more feasible to attach a portable urinal. The operation of excision of the imperfect bladder and transplantation of the ureters into the penile gutter possesses both these advantages, and is perhaps a better procedure

FIG. 443.

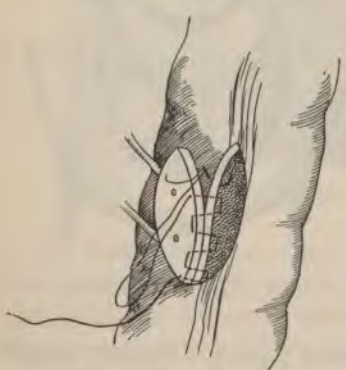

FIG. 444.

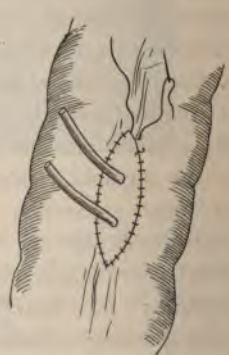

FIG. 445.

than any of those which seek to reconstruct the bladder. In performing plastic operations such as those described it is very difficult to obtain complete union of the transplanted flaps

to their surroundings—hence fistulæ occur which, unless closed, nullify the operation. One very grave objection to the plastic operations which provide the new bladder with an epidermal lining is that urinary salts are inevitably deposited on the bladder-walls and cause much distress. No matter how carefully the flaps have been selected, fine hair is liable to grow on them and give rise to complications. *Prima facie*, one would think that when the new bladder is lined with true mucous membrane, as in Rutkowski's operation, the danger from calculous deposits would be obviated, but experience shows this not to be true; hence the same objection obtains.

When simple uretero-sigmoidostomy or uretero-colostomy is performed, infection inevitably passes up the ureters and leads to a fatal issue. Maydl's idea that transplantation of the ureters, plus their sphincteric attachment to the bladder-walls, avoids the danger of infection ascending from the gut seems correct and is the operation of choice. The lower gut is or becomes very tolerant to the presence of urine, and the anal sphincter is capable of retaining the urine for a very respectable length of time. No other treatment has given results equal to those obtained by Maydl's method.

Operative Treatment of Rupture of the Bladder.—The diagnosis of rupture of the bladder from the symptoms alone is not always possible before it is too late to be of aid in treatment. Other or operative means of diagnosis are often essential.

Diagnosis by Operation.—When the patient has overcome initial shock (twelve to twenty-four hours), or immediately if his condition warrants, diagnosis by operation may be attempted.

I. Injection of air or water into the viscus. By injecting air or water into the bladder, should the viscus be ruptured, no globular tumor will form over the pubis, and when the water is allowed to flow back, much less will return than was injected. Should there be no rupture, the distended bladder will be easily found in its normal site.

The above operation has often served a good purpose, but Schlange points out that the water or air introduced under pressure

is liable to cause separation of peritoneum from the bladder along a ragged rupture—quite a serious objection. Another objection which might be urged is that in the case of an extraperitoneal rupture the air or water might easily distend the bladder to its normal limits and so lead to mistake.

II. Several surgeons have recommended perineal section and examination of the bladder through the wound. This has but few advantages over the next method, and is possessed of many disadvantages.

III. Suprapubic cystotomy. Without the aid of rectal distention the surgeon cuts into the bladder above the pubis. Under the special circumstances (empty bladder, etc.) much care must be taken to "hug" the pubis. The bladder having been opened, the finger soon discovers any ruptures of its wall.

If intraperitoneal rupture is present, the skin-wound is enlarged upwards and the belly opened. Any bloody urine in the peritoneal cavity is gently sponged away. It may now be necessary to put the patient in the Trendelenburg position. The ragged wound of the bladder is examined, and if necessary, some of its bruised edges trimmed away. A line of chromicized catgut sutures is put in place. These sutures pass through all the coats of the viscus except the mucosa. A line of Lembert sutures is inserted superficially to protect the deep ones. The abdominal cavity is now cleaned, either by flushing with normal salt solution or by gentle sponging with gauze pads. The laparotomy wound is closed with or without drainage.

In extraperitoneal rupture the danger is, of course, from infiltration of urine. The suprapubic cystotomy guides the surgeon to the threatened or affected regions and he can at once provide free drainage by appropriate incisions and by packing such regions with iodoform gauze. Bleeding must be stopped either by ligature, pressure, or packing.

How ought the suprapubic wound of the bladder to be treated? In such cases it ought always to be left open. Schlange unites the vesical mucous membrane to the skin by a few stitches. The bladder itself is lightly filled with iodoform gauze, so that it is

constantly emptied of urine by capillary drainage. Permanent catheterization of the ureters and packing of the bladder is a tempting procedure which would be liable to lead to ureteritis and pyelitis.

Suprapubic Cystotomy.—The operation of suprapubic cystotomy may be required for the removal of calculi or neoplasms from the bladder, for the removal of enlarged lobes of the prostate, for purposes of exploration and the treatment of various vesical lesions, and for the carrying-out of retrograde catheterization, etc. Preliminary treatment varies according to circumstances—in one case, *e. g.*, prostatectomy, it is wise to endeavor to cleanse the bladder by appropriate means; in another case, *e. g.*, bleeding villous tumors, such treatment is calculated to encourage serious hemorrhage; in cases of cystitis where treatment *per urethram* is a failure, the cystotomy is undertaken to provide drainage, and the failure of other treatment means failure to cleanse the bladder. In all cases the large intestine should be well emptied before operation. Local or general anæsthesia is requisite. The writer has always used the general anæsthetic.

Shave the pubis and cleanse the hypogastrium and the penis. Introduce a catheter and irrigate the bladder with warm salt, boracic acid, or Thiersch's solution. When the irrigation is finished, distend the viscus with the solution or with air. Remember that in cases of old cystitis the bladder-wall is often very weak and cannot safely be greatly distended. A good plan is to test the capacity of the bladder before any anæsthetic is administered and act according to the knowledge gained. Many surgeons prefer air distention to fluid. Air is said to bring the viscus more easily against the abdominal wall, and when the bladder is opened, there is no gush of infected fluid over the field of operation. These advantages are of no great value and most surgeons prefer the warm aqueous solutions, which are more easily sterilized and managed than is the air. Having distended the bladder within the limits of safety, withdraw or plug the proximal end of the catheter and tie a rubber band around the penis to prevent the escape of the water or air. If the catheter is left *in situ*, it acts as a guide to the bladder.

Some surgeons endeavor to lift the bladder still more against the belly-wall by inserting a rubber bag into the rectum and distending it with air or water. This procedure is unnecessary and has led to many serious injuries being inflicted on the rectum. Even distention of the bladder itself is not *absolutely* necessary, but when possible, is always of immense value, as it pushes the vesical fold of peritoneum upwards and makes the extraperitoneal exposure of the bladder easy.

Place the patient in the Trendelenburg position, as this enlarges the extraperitoneal area through which one must proceed.

I. *Vertical Incision.*—Beginning on the pubis near its upper edge, make a vertical median incision upwards for from 3 to 4 inches. Expose and divide the anterior layer of deep fascia and separate the pyriform and recti muscles. Carefully pick up and divide the deep layer of fascia, thus exposing the prevesical fat. Hook the finger behind the pubis and pull the prevesical fat, and with it the vesical fold of peritoneum. Recognize the peritoneal fold and retract it upwards out of danger. Rarely the peritoneal fold may be adherent to the pubis and must be freed by blunt or sharp dissection. During the manœuvres described the peritoneal cavity may be accidentally opened. This accident is only important if not promptly recognized and corrected by a few carefully placed sutures. Expose the anterior wall of the bladder by bluntly dissecting through the fat in front of it. Once the peritoneal fold is recognized and retracted, do not hug the posterior surface of the pubis too closely, as to do so means exposure of the bladder at a level difficult of access and where it is very vascular; it also means the formation of a ragged pouch difficult to drain, in very unresisting tissue. The nearer its dome the bladder can be exposed extraperitoneally, the better. The bladder will be recognized by its globular form, if distended, or by the catheter in it if it is not distended. It has a brownish-red color, and one can see the longitudinal fibres of the detrusor muscle on its surface.

The bladder having been *freely* exposed, pick up a portion of its wall with a sharp [illegible] or volsellum, and with a strongly

curved needle pass two long sutures through its walls parallel to the direction in which it is desired to incise the bladder. These sutures serve as convenient tractors. Jacobson omits their use, as he thinks they do more damage than forceps attached to the edges of the incision. The writer has never seen harm result from the thread tractors, and they are certainly much more convenient than forceps, which always impede further operative work. Incise the bladder, either vertically or transversely, sufficiently to admit one or two fingers. The transverse incision is the better; it is more readily enlarged and more readily closed. If the vertical incision is chosen and requires enlargement, such enlargement must be done downwards in an awkward location, deeply behind the pubis. If for the purposes of the subsequent steps of the operation (removal of calculi, tumors, etc.) the wound in the parietes is found too narrow, more space may be obtained by making a number of small incisions or nicks in the edges of the recti muscles, or these muscles may be separated from their pubic insertion. More room has also been obtained by subperiosteal excision of part of the pubic bones. Such extreme measures to gain space are rarely necessary.

The treatment of the various lesions met with in the bladder will be discussed later.

Treatment of the Wound in the Bladder.—If the bladder is not seriously infected or the wound has not been greatly contused, *e. g.*, by the removal of stones, etc., the opening may be closed in whole or in part. If marked vesical infection is present or if the walls are much contused, it may be necessary or judicious to leave the wound wide open.

Closure of the Vesical Wound.—If the mucosa is inclined to bleed, unite the edges of the wound in it by a row of continuous fine catgut sutures. With fine catgut on a rounded needle (one without cutting-edges) unite the edges of the wound in the muscular wall of the bladder. If it can be accomplished without undue tension, bury the layer of muscle suture by a row of stitches inserted in the Lembert fashion and composed of fine silk or celluloid hemp. It is very desirable to have an inverted wound

with wide surfaces in apposition. Close the wound in the parietes after providing tubular or cigarette drainage for the prevesical space. If the bladder is completely closed as above, urine must be drawn off frequently by the catheter or permanent catheterization must be kept up. It is a very good and eminently safe precaution to provide perineal drainage before closing the vesical wound. This may be done as follows: Through the suprapubic opening pass a closed forceps through the internal meatus into the membranous urethra. Place the patient in the lithotomy position. With the forceps above mentioned make prominent the membranous urethra just behind the bulb. Cut down on the point of the forceps and with them seize and pull into the bladder the end of a soft-rubber catheter (No. 36 Fr. or larger). With a stitch fix the catheter to the perineal wound. Proceed with the closure of the suprapubic wound.

If it is desired to establish suprapubic drainage, partially close the wound, if it is too large, and introduce into the bladder a $\frac{1}{4}$-inch rubber tube or even two such tubes. The ends of the tubes should not impinge against the base of the bladder and they should be cut so as to be bevelled and be provided with lateral openings. In such cases it is wise to sew the bladder to the parietal fascia around the point of exit of the tubes. This is to prevent as much as possible seepage of urine into the abdominal wound. When the vesical wound is not large and drainage is desired, one may proceed as follows: Dress a $\frac{1}{4}$-inch rubber drain by covering it with two or three layers of gauze; this in turn covered by rubber tissue (practically a cigarette drain with a tube through its centre). Introduce the end of the drain a very short distance into the bladder. With catgut suture the edges of the bladder wound to the drain or its dressing. Push the tube a little further into the bladder; this inverts the edges of the bladder wound. In the Lembert fashion, with catgut, suture the surface of the bladder all around the wound to the tube. We thus have a double line of sutures (catgut) uniting the bladder to the tube and forming a water-tight joint. Fix the ends of the last row of sutures to the parietal fascia so as to

keep the bladder in contact with the abdominal wall and close the wound in the latter. The water-tight joint around the tube is intended to keep urine and infection away from the prevesical fat and the abdominal wound until healing has progressed, to some extent, at least.

If from any cause it is deemed proper to leave the vesical wound entirely open, it is wise to attach its edges to the fascia abdominalis by a few points of suture, and to pack its cavity loosely with iodoform gauze.

It is easy to attach with a glass joint a long piece of tubing to the bladder drain and by siphonage conduct the urine to a suitable receptacle placed beneath the bed.

II. *Transverse Incision.*—Bardenheuer and many other surgeons prefer a transverse to a vertical incision, as more room is obtained. The disadvantage of this method is the liability to subsequent hernia. In cases of intravesical tumor the transverse incision is specially good. Place the patient in Trendelenburg's position. Make a slightly curved horizontal incision through the skin from the neighborhood of one external inguinal ring to the other, immediately above and parallel to the pubic bones. Divide the fascia covering the recti muscles. Separate the recti, pyramidales, and the linea alba from the bone. The retraction of the muscles gives a wide space for the subsequent work; if more space is required, separate the recti from each other vertically. The rest of the operation is the same as that already described.

Suprapubic Lithotomy.—This operation is practically that of cystotomy plus the removal of the stone. If the calculus present is believed to be large, the transverse incision is the better, as it gives more room. It is bad practice to drag a stone out through too small an incision, as the resulting trauma is far more noxious than the making of a larger opening by a sharp, purposeful cut. Calculi must be removed by approximate forceps or scoop (Figs. 446 and 447). In the absence of these special and very convenient instruments, common sense informs us that the same object may be attained, though less expeditiously, by the use of

the fingers, ordinary forceps, or a loop of wire. The suprapubic route insures a good survey of the interior of the bladder, and hence prevents the not uncommon fault of overlooking a second or third stone. Remember that a second calculus may lie encysted in the pouch behind the prostate. When there is no great infection present, it is good practice to establish perineal drainage in the manner already described and close the suprapubic wound. If infection is considerable, suprapubic drainage ought to be established, either alone or in combination with perineal. The after-treatment consists in keeping the bladder clean; the cystitis usually quickly subsides on removal of its cause.

FIG. 446.

Suprapubic Cystotomy for Benign Neoplasms.—Benign neoplasms are usually pedunculated; they may be single or multiple, sometimes being very numerous, filling up most of the space in the bladder. Most vesical papillomata bleed easily, and on account

FIG. 447.

of this tendency it may be convenient to throw into the bladder, immediately before operation, a small quantity of a solution of adrenalin. The advantage gained by the use of adrenalin is that less bleeding occurs during the active operation and hence the surgeon sees better what he is doing; whether hemorrhage is more or less liable to occur secondarily, *i. e.*, after the effects of the drug have worn off, is another matter, and not yet proved.

The bladder is opened preferably by the transverse incision, because of the free access obtained. When the tumor is pedunculated, seize its base in a curved clamp and cut away the free portion of the growth. Never drag upon the forceps so as forcibly to tear away the growth. Sometimes the tumor is so delicate that mere pressure with the forceps separates it from its base. When possible, excise with scissors the portion of the pedicle grasped by the forceps and close the wound in the mucous membrane with one or two points of catgut suture. The finger of an assistant pushing up the bladder from the rectum may aid greatly in this work when the site of the trouble is on the posterior bladder-wall. If the tumor is sessile or has a broad base, cut it away with scissors, as close to the bladder-wall as possible, and cauterize the stump with the thermocautery. Somes surgeons operate on tumors and various bladder lesions through a kind of coffer-dam, so as to avoid urine and blood from other parts obscuring the field of operation. The model on which all such coffer-dams are made is the old Ferguson's tubular vaginal speculum, passed through the abdominal wound and enclosing in its distal opening the area to be attacked. The coffer-dam undoubtedly is a great aid in operating, but it has the serious disadvantage of requiring, for many purposes, the use of special scissors and forceps to permit of work being done through its narrow lumen. After the removal of tumors drainage is essential, and the use of various antiseptic and more especially astringent douches is advantageous. Repeated operations may be necessary before all the neoplasms are removed. If hemorrhage is alarming, the bleeding areas may be packed with iodoform gauze.

Nitze and Sonnenburg write as follows: ("Handbuch der practischen Chir.," iii, 838): "Passing one or two fingers gently into the bladder, one informs himself as to the nature of the tumor and the manner of its origin on the bladder-wall. If, as is very common, the tumor is a large, solid, villous growth with a pedicle, or if a pedicle can be formed by cautious pulling on the tumor, catch it gently but firmly between the fore- and middle fingers and pull it upwards from the mucous membrane for such a distance

that a curved forceps or clamp can be applied to the pedicle between the fingers and the mucosa. By careful but strong traction on the locked forceps endeavor to bring the base of the tumor up to the level of the external wound. It is astonishing how far up continued traction can bring the mucous membrane of the base of the bladder without injury to the patient. If the tumor is large, it often prevents ocular inspection of the mucosa around its base and the necessary recognition of the ureteral openings. Under these circumstances one tears away the villous masses from their pedicle; no hemorrhage results because the forceps are *in situ* compressing the pedicle. The whole field of operation being exposed to view, pass two silver wires through the portion of bladder-wall that is pulled up by the forceps, at a considerable distance from the pedicle, and then with the knife or cautery (knife-blade) excise the pedicle, and with it some of the surrounding mucosa. Injury to the ureters can usually be avoided during the extirpation of benign neoplasms even if the latter are situated at their orifices, but their injury generally does no harm; even complete excision of the ureteral orifices is well borne. After extirpation of the base of the tumor the silver wires already in place prevent retraction of the field of operation and thus hemorrhage can be more readily attended to, and sutures introduced, after which the silver wires are removed."

Malignant neoplasms cannot be efficiently treated in the above fashion. All nibbling, hesitating methods are worse than useless, merely stimulating to increased rapidity of growth. The principles of operation are identical with those for operation on carcinoma located elsewhere, viz., wide and complete removal; partial or total cystectomy.

The most serious form of non-malignant ulcer of the bladder is the tuberculous, and this will be taken as the type in discussing the operative treatment of ulcer. As in other locations, so also in the bladder, rest is a *sine qua non* of treatment. Drainage through the suprapubic, the perineal, or through both routes is the best means of obtaining the necessary rest, and in cases of simple ulceration may be essentially all the treatment required. When

the ulceration is tuberculous, further operative treatment is necessary. Open and explore the bladder. A cold electric lamp introduced through the wound is a great aid, as also is light from a head-mirror or lamp. If the ulcer is solitary, limited in extent, and situated on the anterior part of the bladder from which the peritoneum can be stripped, it is wise to excise the affected portion of vesical wall and close the wound completely after providing perineal drainage. If the ulcer is situated at the base of the bladder,—and this is commonly the case,—cauterize it with the thermocautery or with pure formalin and rub iodoform into it. The subsequent local treatment must consist of drainage and lavage with suitable antiseptic lotions. General treatment is of the utmost importance—good food, fresh air, tonics, and some form of guaiacol are our main reliance.

The natural resisting power of the bladder against tuberculosis is well illustrated in cases of tuberculous nephritis and ureteritis in which secondary lesions appear in the bladder around the ureteral orifices. After nephrectomy and ureterectomy the vesical lesions often disappear spontaneously. This fact encourages us in the treatment of vesical tuberculosis.

Suprapubic Prostatectomy and Prostatotomy.—Open the bladder and explore so as to recognize the variety of prostatic enlargement present and the presence or absence of vesical calculi. If the latter are present, remove them.

I. *Enlarged Pedunculated Middle Lobe.*—This lobe may be the sole obstacle to urination, forming a valve which occludes the vesical meatus.

Method A: Cut through the pedicle with scissors and remove the lobe. Hemorrhage is easily controlled by temporary pressure with pads wrung out of hot water.

Method B: Incise or tear through the mucosa covering the lobe and shell it out with the finger. This method is available whether the hypertrophied lobe is pedunculated or not.

Never omit to examine the prostatic urethra, lest the lateral lobes impinge upon it and require removal.

II. *Enlarged Lateral Lobes with or without Enlargement of the Middle Lobe.*—Introduce a gum-elastic catheter into the bladder through the urethra, to act as a guide to the position of the prostatic urethra. Make an incision through the mucous membrane over the most prominent part of the swelling. With the finger, aided if necessary by closed blunt-pointed scissors, peel the mucosa from the surface of the prostate. Insinuate the finger through the mucosal wound, between the prostate and the urethra, and separate these structures. In the same way separate the outer surface of the prostate from its surroundings, the finger passing between the true and false prostatic capsules. The fingers of an assistant should be passed through the anus to elevate and steady the prostate. Working as above, the prostate may be removed in one piece or in two or more sections. Freyer is often successful in leaving the prostatic urethra intact, though when it is injured, no harm seems to result. Moynihan removes the prostatic urethra with the gland. It is claimed that when the two lateral lobes are removed separately the ejaculatory ducts are not destroyed. Hemorrhage is easily controlled by temporary pressure with pads wrung out of hot water. Freyer introduces a large drain into the bladder through the abdominal wound and sutures the vesical wound around it. Through the tube irrigation with hot water may be practised and any blood-clots removed. The drain is kept in position for about one week, when it is removed and the wound permitted to close. Very excellent results have been reported from this apparently severe operation. Fuller, after completing the enucleation of the prostate, establishes perineal drainage and closes the suprapubic wound. In cases in which there is much infection it is probably best to maintain both perineal and suprapubic drainage for a few days. Prostatectomy via the perineal route will be described on another page.

Cystectomy.—Cystectomy may be partial or complete.

Partial Cystectomy.—This operation is most commonly indicated in cases of circumscribed malignant neoplasm, and whenever feasible should be carried out extraperitoneally. The anterior wall, most of the fundus, and sometimes even part of the posterior

wall of the bladder may be exposed without opening the peritoneal cavity. Expose the bladder as in suprapubic cystotomy. Carefully pull the prevesical fold of peritoneum upwards, and by blunt dissection separate its vesical layer from the bladder to the desired extent. If the peritoneum is accidentally torn, the tear must be at once closed with sutures. Having exposed the bladder at the site of the tumor (anterior wall or fundus) open it and remove the whole thickness of the diseased portion, making the necessary cuts in healthy tissue. Remove too much rather than too little tissue along with the neoplasm. Close the wound by sutures exactly as in suprapubic cystotomy, after providing for drainage—preferably through the perineum.

If the neoplasm has infiltrated the bladder-wall so as to attack the peritoneal covering and its location is favorable, the operation may still be accomplished practically extraperitoneally. Expose the bladder and reflect the peritoneum from it except where it is adherent over the site of the neoplasm; with scissors cut around the site of adhesion; with sutures close the gap in the peritoneum and remove the diseased cystic wall as already described.

When the disease affects the posterior bladder-wall but does not infiltrate the peritoneal covering, it may be removed as follows: Apply a solution of adrenalin to the bladder so as to control hemorrhage, not from any fear of loss of blood, but to keep blood from obstructing the view. Incise the bladder-wall all around the neoplasm, cutting in healthy tissue. Cut down to but not through the peritoneal coat. Remove the disease, along with the whole thickness of the wall, minus the peritoneal covering. Close the wound by a layer of sutures (catgut) involving the muscular coats alone, and one involving the mucosa alone. Should the peritoneum be accidentally opened, close it at once by a few catgut or fine silk sutures. The operation as above described involves more precise suturing than most surgeons are capable of doing. It must require marvellous skill to suture *with precision* the various vesical coats when the work has to be done at the bottom of a deep cavity. If the peritoneal covering in uninjured, prob-

ably the best method to pursue is to make the stitches involve the muscular and mucous coats. These stitches will probably not secure complete union; there will be separation of the edges in time, but they will lessen the size of the defect and so hasten recovery. If it is possible to pull the wound up towards the surface of the body, then of course its closure is easy.

When the tumor is situated at the trigone, the operation is very much as above described. One cuts through the bladder-wall layer by layer until the perivesical fat is reached, and then removes the disease. If the ureter is involved in the disease, pass a catheter into it and dissect it free from its surroundings for about two inches; remove such part of it as may be diseased; secure its ends temporarily by a thread. After the resection of the bladder-wall is completed unite the ureter once more to the bladder. Occasionally it has been necessary to anastomose the ureter to the rectum or skin; this is very undesirable.

An account of Young's method of partial cystectomy is given in the section on Excision of the Seminal Vesicles.

Rutkowski's Operation for the Repair of Defects in the Bladder-wall.—Scope of operation: Rutkowski's operation may be used to close the bladder in cases of ectopia. It also promises to be useful in repairing the bladder after the removal of tumors. In describing the operation it will be assumed that the case is one of tumor.

The operation: 1. Open the belly by a 4-inch incision in the middle line near the pubis. Expose the bladder.

2. Excise the tumor and as much of the vesical wall as may be necessary.

3. Pull a loop of ileum down towards the bladder and divide it at two places (X–X, Fig. 448). The distance between the two lines of section (X–X) depends on the size of the defect in the bladder which it is desired to close.

4. The afferent and efferent loops of ileum (A and E, Figs. 448 and 449) are united by end-to-end anastomosis and at once returned to the abdominal cavity.

5. The isolated segment of ileum (S, Figs. 448 and 449) is split

along its free border (*i. e.*, along the side opposite to the mesenteric attachment). A flap of tissue is thus obtained (F, Fig. 450) which is rectangular in shape, covered on one side by mucous membrane, on the other by peritoneum, and contains non-striated muscular fibres. To the middle of its serous surface is attached the mesentery through which it is nourished.

6. The edges of the flap are attached to the edges of the defect in the bladder by a double layer of sutures. The mucous surface

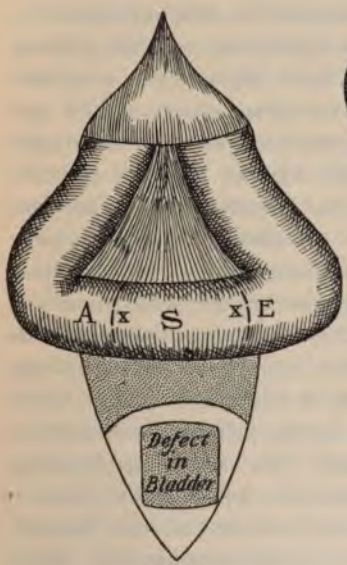

FIG. 448.

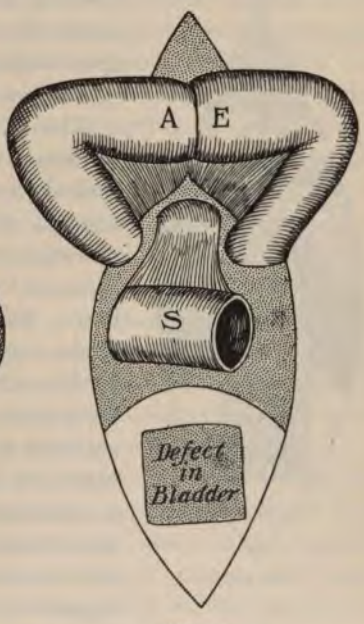

FIG. 449.

of the flap faces the interior of the bladder. The deep layer of sutures (catgut) includes the whole thickness of the bladder and of the gut walls except the surface of the mucous membrane. The superficial layer (silk) is applied after the Lembert method. Continuous sutures are used.

7. A catheter is passed into the bladder *per urethram* and is kept there.

8. The abdominal wound is closed.

Mikulicz has modified the above operation. After isolating a segment of ileum and uniting the afferent and efferent loops (Step 4), he closes, by suture, one end of the isolated segment and sutures the other, or open end, to the abdominal wound near the bladder. The abdominal wound is closed. After a sufficient period of time has elapsed to demonstrate that the segment of ileum is sufficiently nourished, he proceeds to remove the vesical tumor and repair the bladder with the segment of ileum obtained at the first operation.

FIG. 450.

Complete Cystectomy.—Tuffier ("Revue de Chir.," April, 1898) reports a successful case of complete cystectomy in a man suffering from extensive epithelioma confined to the bladder. In his case the operation was complicated by a previous suprapubic cystotomy having been practised. The complication was overcome by packing the bladder with gauze and by dissecting the fistulous tract free from the parietes. Ample room for work was obtained by a combination of the transverse and vertical incisions recommended in cystotomy. The steps of the operation were, briefly, as follows: Exposure of the anterior surface of the bladder. Separation of the anterior and lateral surfaces from the peritoneum and adjacent structures. It is thus easy to isolate the neck of the bladder and the pedicles containing the inferior vesical vessels and the ureters. Clamp the vessels and ureters together and cut between the clamps and the bladder. Divide the neck of the bladder between clamps and cauterize the opened urethra. It may be well to make the division of the vesical neck with the cautery. With forceps or clamps pull the bladder into the abdominal

wound and decorticate, *i. e.*, separate, it from its peritoneal covering under traction. Tuffier succeeded in doing this without opening the peritoneal cavity. If the peritoneum is torn, the opening must be closed at once with sutures. Having removed the bladder, turn to the pedicles containing the vesical vessels and ureters. Isolate the ureters and tie the vessels. Pass a catheter into each ureter and fix it to the ureter with a stitch. Ligate the vessels in the urethral stump.

In Tuffier's case he at once anastomosed the ureters to the rectum, but the union evidently gave way, as the patient developed a suprapubic fistula. If the patient is in poor condition, it is wise to bring the ureteral catheters out through the suprapubic wound and leave any attempts at anastomosis until later. After attending to hemostasis, pack the cavity with gauze and partially close the wound with sutures. Tuffier's classical case lived in comfort for seven months. In the female, Pawlik operated in two stages with an interval of about three weeks. His operation may be performed as follows:

First Stage.—Uretero-vaginal anastomosis. Catheterize the ureters. Incise the vagina over each ureter. Divide and bring the end of each ureter into the vagina. Split the lower end of each ureter for about $\frac{1}{3}$ inch and suture the edges of the split to the vaginal wound. Fix with stitches a catheter in each ureter.

Second Stage.—Excision of the bladder. Fill the bladder with an emulsion of iodoform. Through a suprapubic incision separate the bladder from its surroundings down to the urethra. Empty the bladder. Pack the suprapubic wound with gauze. Make an incision through the anterior wall of the vagina at a point opposite the internal urinary meatus, pull the isolated bladder through this incision, and divide it where it joins the urethra. Remove the bladder. Pass ureteral catheters through the urethra into the ureters. Denude and close by sutures the vaginal outlet, thus forming a urinary reservoir drained by the urethra.

Complete extirpation of the bladder can be justifiable only in cases of malignant disease where the patient is in constant

agony, and even in these cases its propriety is doubtful. Tuffier's operation seems to have prolonged his patient's life and made it more or less comfortable. Pawlik's patient subsequently suffered from incontinence and calculous disease. The mortality from the operation is, of course, very great.

Operative removal of benign neoplasms gives good results; the extirpation of malignant growths occasionally does so.

Prostatotomy.—The principle at the base of all operations for the relief of the troubles arising from enlarged prostate is the provision of drainage for the most dependent portion of the bladder. Such drainage may be secured by suprapubic prostatotomy.

Expose and open the bladder by the vertical incision. Explore the bladder and recognize the nature of the prostatic obstruction. Introduce a tubular speculum (caisson or coffer-dam) and engage the prostate in its open end. The use of this is not essential. With gauze pads dry the surface of the tissues enclosed in the end of the speculum. Pass a thermocautery, heated to a red heat, through the speculum and burn a groove or gutter from the prostatic urethra to the vesical pouch behind the prostate. This provides drainage of the most dependent portion of the bladder. If the lateral lobes of the prostate obstruct the urethra, it is well to burn deep grooves or gutters in them also. Provide suprapubic drainage and partially close the wound. This operation is very similar in principle to the Bottini operation, but it is done under guidance of the eye.

Galvano-caustic Prostatotomy (Bottini's Operation).—The object of the Bottini operation is to make one or more furrows through the obstructing prostate, thus lowering the vesical orifice of the urethra and permitting efficient drainage of the bladder.

The favorite instrument for division of the prostate is Trendelenburg's modification of Bottini's galvano-cautery (Fig. 451). H. Young has devised an instrument in which various sized blades can be used ("Jour. Am. Med. Assoc.," Jan. 11, 1902).

Da Costa thus describes the operation: "The bladder should be emptied, irrigated, and distended with air, and the posterior

urethra must be anæsthetized by instillation of cocain or eucain. The current is tried to see how many seconds it requires to heat the blade sufficiently. The current is broken, the instrument is introduced, the cooling current is set in motion, and one assistant watches this and nothing else. Turn on the current. Wait the required number of seconds for the blade to become red hot (twelve to fifteen seconds), turn the screw at the handle, and burn a groove in the prostate. A groove should be burned towards the rectum, one to the side, and, if it is thought desirable, one to the opposite side. No groove should be burned towards the pubes. When a groove has been burned, return the blade into its sheath, increasing the current while doing so in order to keep the blade from adhering to the tissue, and then shut off the current. After withdrawing the instrument it is not necessary to introduce and retain a catheter. The patient is confined to bed only twenty-four hours, there is rarely bleeding or fever, and the results are good. The scars contract and the gland atrophies. During the period of healing a steel sound should be passed from time to time (Bangs)."

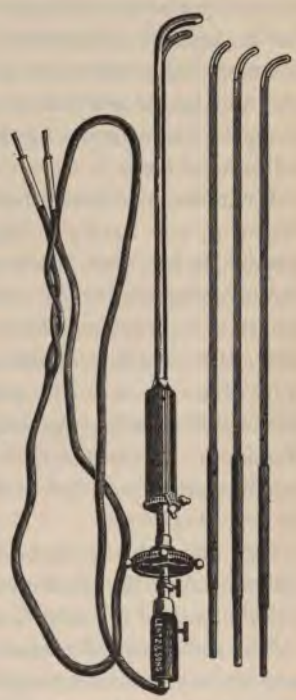

FIG. 451.—(*Da Costa.*)

Chetwood has devised a short cautery which he introduces through a perineal opening and so escapes the grave danger of urethral injury mentioned on page 507.

For the indirect treatment of prostatic hypertrophy J. W. White has strongly recommended castration, and R. Harrison and

Mears, vasectomy (division or resection of the vasa deferentia). These operations are too simple to require description.

Remarks on the Treatment of Prostatic Hypertrophy.—The patients are almost always aged in years and still more aged in physical condition. Unfortunately, until recently, operation has been considered the last resort, hence the patients have been permitted to get into a very dreadful condition. The operation required for cure is always one of severity, hence if the patient can be kept in a fair state of comfort and health by palliative treatment, such treatment is the best. Whenever hygienic measures and the proper use of the catheter fail to give relief, it is wrong to waste time; the patient must be given the option of radical treatment.

Castration or orchidectomy is the least efficacious method of treatment, and having a high rate of mortality and of induced insanity, it has been practically discarded. Vasectomy possesses any advantages which may pertain to castration and is much less dangerous. It has no effect on fibrous and adenomatous enlargement, but favorably influences congestive conditions. It seems to be of use in cases of "prostatismus" where the symptoms of prostatic hypertrophy are present, but there is no residual urine. Wassiljew ("Centralblatt f. Chir.," 1903, No. 26) thinks the benefits derived are due to the resulting lowering of the tone of the vesical sphincter.

The main objects aimed at by operations on the prostate are (1) removal of the cause of the obstruction, (2) lowering of the vesical mouth of the urethra so that the bladder may empty itself.

The most surgical means of attaining the above objects is by prostatectomy, either suprapubic or perineal. Both these methods are good in suitable cases. Where the perineum is deep or where the hypertrophy is mainly intravesical, the suprapubic route is the better. Most forms of hypertrophy can be removed by the perineal route, and this route gives the better drainage. To-day perineal prostatectomy is the operation of choice with most surgeons. Whichever method is chosen, the operation is one of severity and ought not to be undertaken when renal disease

is present. Prostatotomy, whether accomplished via the suprapubic route by means of a thermocautery or through the urethra, as in the Bottini operation, attains one of the objects of radical operation in that it lowers the vesical orifice of the urethra. The suprapubic method has the advantage in being done under the guidance of the eye, with inexpensive instruments, and in requiring no special manual training. The disadvantages are the necessary suprapubic cystotomy and the fact that the resulting scar in the prostate is thicker and clumsier than that left by the galvanocautery. The Bottini operation has been thoroughly tested by many surgeons, notably by Horwitz and Willy Meyer, the latter having operated 71 times on 59 patients without any reference to the character of the lesion or the presence of renal or other disease. Out of the 59 cases 7 died, but the death was the direct consequence of the operation in but 3.

The author has seen one case in which, owing to some unsuspected flaw in the instrument used, the urethra was severely burned, and in part obliterated, while the prostate itself had escaped without being cauterized. The condition of the prostate was demonstrated during a subsequent suprapubic operation done by J. Block, to establish drainage. The operator was a surgeon of great experience in this class of work. Meyer's experience is so valuable that his conclusions may well be quoted here:

"1. The operations making a direct attack upon the enlarged prostate gland are preferable to those aiming to exert an indirect influence.

"2. We have *two* useful procedures for the direct treatment of the enlarged prostate gland—*i. e.*, prostatectomy and galvanocaustic prostatectomy (Bottini's operation).

"3. In selecting the method indicated in the given case we must individualize and be guided by anatomical, pathological, and social conditions.

"4. Prostatectomy is the most radical and most surgical pro-

cedure; it should be the operation of choice whenever promising success.

"5. Perineal prostatectomy offers advantages over the suprapubic method, since it enables the operator to do the operation under the guidance of his eyes.

"6. Debilitated patients who seem unfit subjects for the more radical operation should not be at once relegated to catheter life, nor should prostatectomy be performed in order to 'let them down easy.' They should be advised to have a Bottini's operation done, if possible.

"7. Surgcons should familiarize themselves with both methods, in order to be in a position to do justice to their patients.

"8. It is the duty of those refusing to do Bottini's operation under any circumstances, nevertheless to advise the latter in cases where the patient asks for more radical relief and the operation with the knife seems contraindicated.

"9. Further carefully compiled statistics as to the late results of both operative procedures—preferably in the hands of one man—are desirable in that they will increase our knowledge with reference to the selection of the proper method in the individual case." ("Transactions Am. Surg. Assoc.," vol. xxi.)

CHAPTER IV.

PERINEAL SECTION.

PERINEAL CYSTOTOMY.

Perineal cystotomy, or the boutonnière operation, is perhaps the simplest and safest method of opening and exploring the bladder. As a method of exploration it is defective in that it is difficult to reach all parts of the bladder with the finger, especially when the perineum is deep. Ocular inspection is also impossible. As a therapeutic agent it is of great value in providing drainage and giving rest not merely to the bladder, but to the urethra; it also permits the removal of small calculi and neoplasms from the bladder. Perineal cystotomy is one of the steps in certain methods of perineal prostatectomy.

Preparation of the Patient.—Thoroughly evacuate the large intestine by means of irrigation. Irrigate the bladder and partially fill it with warm water or boracic acid solution. Shave the perineum. Cleanse the perineum, scrotum, penis, and hypogastric region. Place the patient in the lithotomy position with the buttocks elevated and well over the edge of the table.

The Operation.—*Step* 1.—Pass a staff, provided with a median groove on its convex side, into the bladder. By holding the handle of the staff close to the hypogastrium force its curve against the perineum, which is thus made prominent. Intrust the staff to an assistant, who holds it steadily and accurately in place. The surgeon now sits down, facing the field of operation.

Step 2.—Protect the hand with a rubber glove and, *per rectum*, palpate the prostate, etc. Having done this, remove the glove. With the fingers of the left hand steady the skin of the perineum and make a median incision from a point posterior to the scroto-perineal junction to within one inch of the anus. Keeping

strictly in the middle line, deepen the incision until the urethral bulb is exposed. Do not injure this structure. Pull the bulb forwards in the middle line and continue the dissection behind it until the staff can be felt in the membranous urethra. Open the urethra on the staff, and freely incise it from the bulb to the apex of the prostate.

FIG. 452.

Step 3.—Guided by the groove in the staff pass a curved grooved director or a Teale's gorget (Fig. 452) into the bladder. Remove the staff. Along the director or gorget push the finger into the bladder with a boring motion. This forcibly dilates the prostatic urethra. With the finger explore for calculi, neoplasm, enlarged prostate, etc. If a small calculus is present, remove it with a lithotomy forceps or scoop. If a small benign pedunculated neoplasm presents, remove it with the finger or by crushing its pedicle with forceps. Be careful not to drag forcibly on the tumor. Sessile or large tumors are better attacked through a suprapubic incision.

Step 4.—Having finished the exploration or the active operation, introduce a drainage-tube approximately equal in size to the exploring finger. Watson's drainage-tube is excellent (Fig. 453). R. Harrison uses a large rubber catheter with a terminal as well as lateral eye. With one or two points of suture make the perineal wound hug the tube. Fix the tube in place with a safety-pin or tapes.

FIG. 453.—(*Esmarch and Kowalzig.*)

Test the patency and efficiency of the drain by irrigating the bladder through it. The end of the tube should reach but not penetrate far into the bladder.

Return the patient to bed, the upper end of which ought to be elevated slightly. The mattress ought to be firm and not sag under the patient's weight, otherwise drainage will be poor. The perineum is covered by dressings kept in place by a T-bandage through which the drainage-tube emerges. It is easy to attach to the drain a long rubber tube which conducts the voided urine to any convenient receptacle. After two or three days the drainage-tube must be changed. The time during which drainage must be kept up varies according to the operation performed. After a simple lithotomy the tube should be removed in two or three days and the wound allowed to heal. In cases of cystitis or posterior urethritis drainage ought to be kept up until the tissues get into a healthy condition.

If in Step 3 forcible digital dilatation fails to give a sufficiency of room, median prostatotomy may be performed. Using the finger in the prostatic urethra as a guide, introduce a probe-pointed knife and with it divide the prostate in the middle line posteriorly. Bleeding may be stopped by pressure from a snugly fitting Watson's drain or by packing the wound with gauze around a stiff gum-elastic drainage-tube. Prostatotomy performed as above is an integral part of some of the procedures for the removal of enlarged prostatic lobes.

As the perineal operations for the removal of vesical calculi (lateral lithotomy, Wood's operation, etc.) are thoroughly described in every text-book on general surgery ("American Text-book"; Moullin; Rose and Carless; Parkes, etc.), they will not be treated of here. The same is true of the operation of litholapaxy.

PERINEAL PROSTATECTOMY.

A very large number of incisions have been described by which the prostate may be exposed in the perineum. When these are analyzed they resolve themselves into two, each of which may be

modified during the operation according to the dictates of common sense.

Method A: Median Incision.—The earlier steps of this operation are identical with those of median perineal cystotomy. When the membranous urethra is opened and the prostatic urethra dilated, pass into the bladder a suitable tractor, and with it pull the prostate downwards into the wound.

Several efficient tractors have been devised for this purpose; the best known are Parker Syms', provided with a dilatable rubber bulb; Young's (Figs. 454, 455), having separable metal blades, and A. H. Ferguson's. In the absence of a special instrument any good stout metal sound answers the purpose.

With scissors or knife incise the fibrous sheath of the prostate; insinuate the finger between the sheath and the gland and enucleate the latter. Sometimes the prostate comes away in one piece, sometimes in two or more fragments. Most surgeons begin the enucleation in the left lobe; this is a mere matter of convenience. "Usually, but not always, the floor of the prostatic urethra is divided when the middle portion is being taken out; but the author has had all his specimens examined by the microscope, and it has been shown that no mucous membrane has been taken away" (except in one case). (Parker Syms, "Brit. Med. Jour.," Nov. 8, 1902.) Drain the bladder by a perineal tube (No. 36 Fr.) fastened to the upper part of the wound. Pack the wound cavity firmly with iodoform gauze. Attach a rubber tube to the drain so as to conduct the urine to a suitable receptacle. Wash out the bladder frequently through the drain. Change the gauze pack after the lapse of twenty-four hours, lessening the amount of gauze used. Encourage the patient to move about in bed and to sit up at the earliest possible moment. This is important. Remove the drain in about one week. After the drain is removed wash out the bladder at intervals by means of a catheter. Occasionally introduce a sound, to maintain the urethra patent. In operating in much the same manner as above described, H. Young divides the prostatic capsule external to the location of the seminal ducts, and believes he is

able to remove a sufficiency of the gland without destroying these structures. That portion of the prostate subjacent to the ejaculatory ducts is not involved in the hypertrophic process and hence can be safely left.

Another method is as follows: Expose and open the membranous urethra as above; guided by the finger passed through the prostatic urethra divide the prostate posteriorly in the middle line with a probe-pointed knife (median prostatotomy). Seize the edge of the divided capsule in forceps, and with the finger separate the capsule from the gland and shell out the latter *en masse* or in pieces. As the enucleation proceeds, it is well to make traction on the lobes, which are being removed, by means of claw-like sharp retractors. Through the urethral wound it is easy to shell out the middle lobe if it is enlarged, and to remove any vesical calculi which may be present. In cases where enucleation with the finger is difficult some surgeons extirpate by *morcellement*, cutting the gland away piecemeal with scissors or rongeur forceps; when this is done, it is advised to begin the extirpation remote from and work towards the urethra.

Method B: Transverse Incision.—Zuckerkandl was probably the first to advocate this method of exposing the prostate. The whole operation has been well systematized by Albarran. Very many operators have devised various modifications in details, using incisions of divers shapes, **H, Y, X,** etc., to increase the exposure of the prostate. Practically, any one of these cuts gives as good results as any other.

Prepare the patient as already described and place him in the lithotomy position with the pelvis well elevated. This posture, a combination of the Trendelenburg and lithotomy positions, is of very great service, being almost essential. Introduce a sound or staff into the bladder and entrust its handle to an assistant.

Step 1.—One fingerbreadth in front of the anus make a slightly curved (concavity posterior) transverse incision through the skin and subcutaneous tissue, from one ischial tuberosity to the other.

Step 2.—Guided by the sound in the urethra expose its membranous portion and bulb. Catch the tissues on each side of the

bulb with volsellum forceps and so pull the bulb upwards out of the way and at the same time steady the perineum. Do *not* open the urethra. Introduce a finger of the left hand (protected by a rubber glove) into the rectum, and with the right hand separate

Fig. 454.

Fig. 455.

FIGS. 454 AND 455.—(*Young.*)

the rectum from its anterior connections—*i. e.*, from the prostate. This may be done by blunt dissection, aided by an occasional cut with scissors. If the surgeon keeps close to the prostate, this step is easy. The finger in the rectum saves injury to that structure.

Introduce a broad, flat, long-bladed retractor into the wound and pull the rectum and posterior surface of the wound backwards, exactly as the vagina is retracted in operations on the cervix uteri.

Step 3.—Make the assistant turn the beak of the sound backwards so as to lie behind the middle lobe of the prostate and pull it down into the wound as much as possible. Instead of a sound Young's (Figs. 454 and 455) or Ferguson's prostatic tractor may be used. The prostate now lies exposed.

Step 4.—Split the prostatic capsule by a transverse or vertical incision as may be convenient. If it is desired to save that portion of prostate corresponding to the urethral floor, make a longitudinal cut on each side through the capsule. Seize the edges of the wound in the capsule with forceps and with the finger insinuated beneath the capsule enucleate the gland. As the enucleation proceeds pull on the part being removed with claw-shaped retractors. If the urethra is accidentally torn, the middle lobe when enlarged can be easily reached and enucleated with the finger. The accident to the urethra does not seem to be of much moment. If the urethra is not opened and a projecting middle lobe is present, it can be reached and removed with the finger through the prostatic wound.

Step 5.—Partially close the deep wound with sutures. Introduce a drain into the bladder and firmly pack the wound with iodoform gauze.

It will be seen that, except in the matter of exposure, the operation by transverse incision is identical with that by median. Undoubtedly by the transverse method a much better exposure of the field of operation is obtained, at the expense of a little more trauma, but most of the actual work is done by the finger unguided by the eye, hence the improved exposure is not of so much value as might appear at first glance.

All the operations here described are carried out inside the capsule; extra-capsular operations have been devised and described, but they occasion so much shock and hemorrhage that they are unsuited to the extirpation of benign neoplasms. While

none of the methods described can be truly named complete prostatectomies, yet they approach so nearly to completeness that they may be termed so for the sake of convenience and to distinguish them from the next class of operations, which are frankly incomplete. Rydygier, Riedel, and others frequently expose the prostate by the transverse incision and content themselves with excising portions of the lateral lobes, opening neither the urethra nor the bladder. The result of taking away such portions of the prostate is that pressure is removed from the prostatic urethra, and as the wounds heal and contract, the urethral lumen is widened. The method is less severe than the more complete operations and has given good results even in cases in which the middle lobe has been enlarged. Of course, the operation is meant primarily for cases of hypertrophy of the lateral lobes and it has a distinct field of usefulness.

INFRAPUBIC PROSTATOTOMY AND CYSTOTOMY.

The prostate and lower part of the bladder may be exposed immediately under the pubic arch. This route avoids the neighborhood of the anus, with its ever-present infection, while it gives more direct access to the prostate and better drainage than does the suprapubic route. If the patient is feeble, the operation may be done in two sittings, the first consisting of the exposure of the prostate, the second of the prostatotomy or prostatectomy. (L. Heusner, " Centralblatt f. Chir.," 1904, p. 217.)

Step 1.—Make a curved incision through the skin along the lower margin of the pubis and its descending rami.

Step 2.—Divide the insertion of the suspensory ligament of the penis; the corpora cavernosa; the ischio-cavernosus muscle; the triangular ligament, and part of the insertion of the adductor muscles. With a chisel or rongeur forceps cut away about half of the symphysis pubis and of the descending rami. Separate the prostate from the posterior surface of the pubes. When this is done, it is easy to pull the prostate downwards and expose its whole anterior surface. Bleeding from the plexus of veins ante-

rior to the prostate is liable to be considerable. If this cannot be sufficiently controlled to permit of further progress, or if, as in Heusner's case, the patient is too weak, it is easy to pack the wound and resume the operation after the lapse of a few days.

Step 3.—Pass a sound into the bladder *per urethram*. Using the sound as a guide, split the prostatic urethra through its whole extent along its anterior or ventral surface. This exposes the prostate exactly as in a postmortem.

Step 4.—Remove all obstructing lobes exactly as is done when other methods of exposure are employed. If it is desired to open the bladder instead of the prostate, this is easily accomplished by the removal of more bone from the pubis. The operation is, however, much more suitable for prostatic than for vesicular disease.

Step 5.—Close the wound in the prostate with a few catgut sutures. Provide for drainage. Close the skin-wound.

CHAPTER V.

EPISPADIAS.

Epispadias is closely allied to hypospadias, and when there is curvature of the organ from fibrous tissue contraction, this must be corrected in the same fashion as in hypospadias.

Thiersch's operation is performed in several stages:

I. Construction of urethra in the glans penis. Parallel to the groove in the glans make two incisions, as shown in Fig. 456, *a* and *b*. Lay a glass or metal rod along the groove, and with it depress the groove, at the same time sliding the lateral portions of the glans (mobilized by the two incisions) over the rod, and unite their

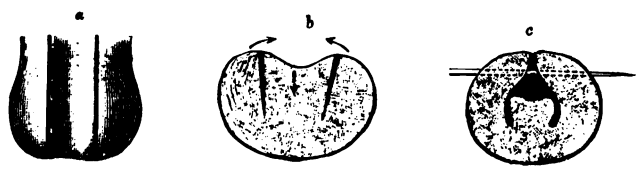

FIG. 456.—(*Esmarch and Kowalzig.*)

raw surfaces by quill sutures (Fig. 456, *c*). When the balanic urethra is safely and firmly established and the wounds healed, proceed to—

II. Construct the penile urethra. Make the skin-flap *a* (Fig. 457) along the whole length of the urethral groove and with its base next the groove. Make the similar skin-flap *b*, with its base remote from the urethral groove. Turn the flap *a* over so that it covers, and has its skin surface next to, the groove. With a few points of suture fix the cut edge of flap *a* to the under or raw surface of flap *b*, near its base (Fig. 458). Pull flap *b* over flap *a* and suture its free edge to the raw surface on the penis left by the

elevation of flap *a* (Fig. 458). In tracing out the two flaps *a* and *b*, the former is made narrower than the latter.

III. A small opening still exists between the new-formed tubes in the penis and glans. In epispadias the incomplete but usually redundant prepuce hangs below the glans. Make a transverse hole through the prepuce near its base (Fig. 458, *c*, *c*) and push the glans through it. The prepuce now lies on the top of the penis, and by suturing the edges of the wound in it to the vivified edges of the urethral defect, the latter can be closed (Fig. 459).

Fig. 457.

Fig. 458.

FIGS. 457 AND 458.—(*Esmarch and Kowalzig.*)

IV. A defect remains at the base of the penis. To close this, vivify the edges of the defect, and forming a flap (Fig. 460, *a'*), turn it over and suture its edges to the edges of the defect, thus providing an epidermal lining to the portion of urethra covered. Another skin-flap (Fig. 460, *a*) is reflected and made to cover the exposed raw surface of flap *a'*. This procedure is objectionable in that the skin-flap *a* will assuredly develop hair and cause trouble. It is

far better to cover the opening with a single flap—raw surface inwards—as Cheyne recommends. The contraction which subsequently occurs is far less objectionable than the growth of hair inseparable from Thiersch's plan.

As is stated in the chapter on "Hypospadias," all operations which provide an epidermal lining for the new urethra from skin in which hair is liable to grow are very objectionable, hence Rosenberger's ingenious

Fig. 459.

Fig. 460.

FIGS. 459 AND 460.—(*Esmarch and Kowalzig.*)

and simple operation is to be condemned and will not be described.

The Van Hook-Mayo operation for hypospadias is entirely suitable in cases of epispadias.

CHAPTER VI.

HYPOSPADIAS.

In hypospadias, owing to an error in development, the urethral floor is defective. The defect may be slight or great, and according to its degree the deformity is of the following types: (1) Balanic, *i. e.*, confined to the glans, the urethral meatus being immediately behind, while the balanic urethra is absent or represented by a mere groove or gutter. (2) Penile type. The urethral opening is situated at any point between the scrotum and the glans; the anterior urethra is absent or represented by a mere groove. (3) Perineo-scrotal type. The urethral opening is in the perineum and the scrotum is divided.

In any form of hypospadias except the mildest the defective penis is curved downwards, and held in a position of chordee, by dense fibrous tissue bands which exist on its lower surface. These bands are an important element in treatment, as no operation can be of any value which does not correct the curvature. Duplay corrects the chordee deformity by making transverse incisions through the fibrous bands. The incisions may be subcutaneous or open, according as the skin is contracted or loose. When the incisions are open, they may be covered by skin-grafts or rendered longitudinal by means of sutures. Bleeding is not great, as any tissues divided are sclerosed. Some surgeons excise much of the scar tissue. The straightening of the penis must be thorough, if requisite, several incisions being employed. While healing is progressing the corrected position may be retained by strapping the penis to the belly-wall. (In cases of epispadias a splint is requisite.) Several weeks may be spent in obtaining a straight organ.

Where the deformity is of the balanic type, the foreskin may be complete or may be divided; in the latter case it is usually redundant and hangs over the glans as a hood. Operation is required

because of narrowness of the urethral opening and because of the great inconvenience arising from the impossibility of directing the stream in urinating. If the urethra is represented by a groove on the under aspect of the glans, it may be converted into a tube by freshening its edges and uniting them over a glass rod, or by an operation identical with that of Thiersch. (See "Epispadias.")

In a case in which the above operation had been unsuccessful the author obtained a good result from utilizing the foreskin in the following way: Vivify one edge of the urethral groove (X Y, Fig. 461). Divide the foreskin along the line X Y. Suture the raw edge of the foreskin wound Y, P, to the freshened edge of the urethral groove (X Y) (Fig. 462). Wait until union has taken place.

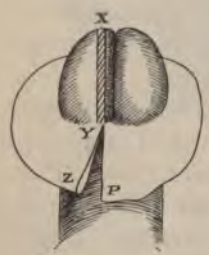

FIG. 461.

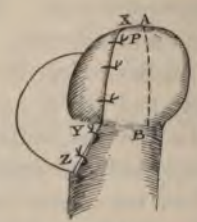

FIG. 462.

FIG. 463.

Divide the foreskin along the line A B, Fig. 462. Freshen the corresponding edge of the urethral groove. Unite with sutures the raw edge of the foreskin to the edge of the urethral groove. The result is shown in Fig. 463.

Beck's Operation.—Beck's operation is suitable, not only in cases where the urethra is defective at the glans, but where it is defective for a short distance behind it.

Dissect the distal end of the complete urethra free from its surroundings for a suitable distance (Figs. 464, 465, 466, 467). This mobilizes the tube so that it can be pulled forwards and sutured to the vivified urethral groove on the under surface of the glans. Where there is no urethral groove on the glans, some surgeons

perforate the glans from before backwards or from above downwards and backwards (Ochsner) and pull the mobilized end of the urethra through the tunnel, suturing it there. When the defect belongs to the penile or scroto-perineal type, other operations are required.

Duplay's Operation.—First sitting: Straightening of the penis.

Fig. 464.

Fig. 465.

FIGS. 464 AND 465.—(*C. H. Mayo.*)

Second sitting: Correction of the deformity in the glans, as in Thiersch's operation for epispadias.

Third sitting: Establish perineal drainage, by the boutonnière operation. C. H. Mayo advises the introduction of a Jacobs' self-retaining female catheter through the perineal wound. Correct the urethral deformity as follows: Make a longitudinal in-

cision (A, B, Fig. 468) parallel to and about ⅜ inch distant from the edge of the urethral groove. At each end of this incision make a transverse incision beginning at the edge of the urethral groove and ending at a point well external to the longitudinal cut. These cuts outline two flaps, one of which (X, Fig. 468) has its base at the urethral groove; the other, P, has its base towards the side of

Fig. 466.

Fig. 467.

FIGS. 466 AND 467.—(*C. H. Mayo.*)

the penis. Reflect these flaps. On the opposite side of the urethral groove duplicate the above incisions and form the flaps Y and Q. Pass a rod through the lately formed urethra of the glans and permit it to lie in the urethral groove. Reflect the flaps X, Y, on to the rod (Fig. 469) so that their epidermal surfaces next to the rod and their raw surfaces are exposed.

These two flaps should *not* be so wide that their edges meet over the rod. Approximate the flaps P and Q by means of the suture S S^1 (Fig. 469). The skin is so loosely attached to the penis that it is easy to slide the flaps P and Q inwards so that their raw surfaces are partly in contact with those of X and Y and partly with one another. The sutures, of silkworm-gut or silver wire, should be fastened to perforated lead plates which extend the whole length of the wound on each side of it (quill sutures). The lead plates prevent the sutures cutting out and assist in keeping the parts at rest.

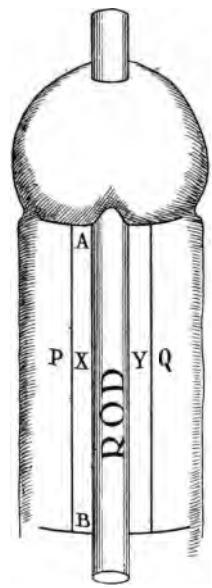

FIG. 468.

The above operation is a modification of Duplay's operation for epispadias. After the penile urethra is completely formed there is still a hiatus between it and the urethra leading from the bladder. This hiatus is closed in the manner described in the chapter on "Epispadias."

Thiersch's operation for epispadias is also suitable in hypospadias.

Many ingenious operations have been devised by which a new urethra is formed from the skin of the scrotum (Rosenberger, Wood, etc.). All these are objectionable in that hair will grow on the skin used in the making of the new urethra and cause an infinity of trouble.

FIG. 469.

Nové-Josserand has devised a most ingenious method of operating, but whether it will prove of much value or not is still doubtful. The operation is performed as follows: Divide the skin transversely immediately in front of the urethral opening (A, Fig. 470). From this cut make a subcutaneous tunnel, by means

of a trocar, to the point of the penis. Cut a large Thiersch skin-graft and roll it around a glass rod, fixing it to the rod by means of a ligature at each end (Fig. 471). Pass the rod covered with the graft through the newly made tunnel in the penis. Apply dressings. After eight days remove the rod. It will be wise to drain the bladder by means of a Jacobs' self-retaining catheter introduced through a perineal incision, and thus avoid con-

Fig. 470.

Fig. 471.

FIGS. 470 AND 471.—(*Monod and Vanverts.*)

tamination of the wound with urine. For a few months after recovery pass sounds at intervals, as there is a tendency to contraction. Van Hook ("Annals of Surgery," April, 1896) and C. H. Mayo ("Jour. Am. Med. Assoc.," April, 1901) have devised very similar operations which may be performed as follows:

"The prepuce is extended as for circumcision and two incisions

are made, about 1 inch apart, extending from its border to its attachment at the penile cervix; the prepuce is unfolded, forming a loop of thin skin about 2½ inches in length. Should this not be considered sufficient to reach from its attachment to the hypospadiac opening, the two incisions are extended back along the dorsum of the penis until sufficient tissue is obtained, where the two incisions are connected by a transverse one, and the flap of skin lifted but left attached to the cervix by the inner surface. Several sutures now close the lateral integument over the denuded

Fig. 472.

Fig. 473.

FIGS. 472 AND 473.—(*C. H. Mayo.*)

area (Fig. 472). The pedunculated flap of prepuce is constructed into a tube with its skin or outer surface inside, by means of a number of catgut sutures. The penis is tunneled by means of a narrow bistoury or medium trocar and cannula, through the glans, above its groove, along the penis to a point beneath the hypospadiac opening, when it is made to emerge at one side of, but close to, the urethra; the tube of prepuce is drawn through the tunnel and sutured where it enters the glans and also where it emerges (Fig. 473). At the end of ten days the pedicle of the flap is cut through close to the new meatus. The second operation, made at a later

period, consists of a perineal opening into the urethra and insertion of a Jacobs' self-retaining female catheter; this is the least irritating form of catheter and can be left as long as needed—usually from five to eight days. An incision at the termination of the two urethras now admits of accurate coaptation by sutures, or the normal urethra may be mobilized (Beck method) to a sufficient extent to admit of its insertion into the new urethra, where it is held by sutures and the external parts closed over this (Fig. 474). Occasionally a little urine escapes into the urethra, and the entire canal is best drained by passing several strands of silkworm-gut or horse-hair through the urethra and out alongside the catheter in the perineal opening."

FIG. 474.—(*C. H. Mayo.*)

CHAPTER VII.

OPERATIONS ON THE TESTICLES.

CASTRATION; ORCHIDECTOMY; ORCHI-EPIDIDYMECTOMY.

I. Simple Castration.—*Step* 1.—Make an incision 2 or 2½ inches in length downwards from the level of the external abdominal ring. Through this isolate the spermatic cord by blunt dissection.

Step 2.—If the cord is not very thick, crush it forcibly with powerful forceps. In the groove formed by the clamp tie a ligature tightly around the whole cord. Thread one end of the ligature on a needle and pass it through a small portion of the cord distal to the main ligature. Once more tie. This stitch obviates any possibility of the ligature slipping. Some surgeons carefully avoid including the vas deferens in the ligature lest pain result. Jacobson believes that if the ligature be applied very tightly pain will not develop. Crushing the cord before applying the ligature has the same effect. When the cord is large, or if for any reason a single ligature seems objectionable, two or more interlocked ligatures may be applied. Absorbable or non-absorbable ligatures may be used at the option of the surgeon. Plain or iodized catgut serves every purpose excellently. Apply a clamp to the cord, about one inch distal to the ligature. Divide the cord between the clamp and ligature. Examine the ligated stump, which may be allowed to retract into the inguinal canal if it is healthy and is not bleeding.

Step 3.—With the hand on the scrotum make the testicle with its coverings protrude through the wound. By blunt dissection, separate it with its coverings from the scrotum, and so remove it.

Step 4.—Carefully review the wound and stop all bleeding.

If drainage is required, perforate the scrotum at a dependent point, and through the perforation introduce a capillary or tubular drain.

Step 5.—Close the wound with sutures. The objects in making the skin-incision at a high rather than a low level are: (*a*) It is more easy to separate the cord and the testicle from its surroundings; (*b*) the whole vascular supply is under control from the beginning; (*c*) it is much easier to retain suitable dressings over the wound.

II. Castration for Malignant Disease.—This operation as commonly performed is a farce and recurrence is certain. The usually described method is that of simple castration, which is as ineffective as simple excision of the cancerous breast when the axillary glands are involved. When the testicle is the seat of malignant disease, the same principle holds good as in the case of the breast, viz., to remove *en masse* the whole organ plus all the *accessible* lymphatic tissue through which it is normally drained. Unfortunately, the terminal lymphatics are not accessible. The lymphatics of the testicle, epididymis, and visceral layer of the tunica vaginalis run along the spermatic cord to the lumbar region. They are usually superficial to but in contact with the blood-vessels. In the lumbar region they leave the spermatic vessels and run towards their terminal glands. The terminal glands are grouped around the aorta (right and left juxta-aortic glands) (Cuneo). The lymphatics of the scrotum terminate in the inguinal glands.

Cumston and Rolfe ("American Med.," 1903, 607) have given a good description of the methods to be employed; the following is largely based on their paper:

Step 1.—Make an incision parallel to and one inch above Poupart's ligament from a point a little below the external inguinal ring to a point about one inch above the internal ring.

Step 2.—Expose the fascia of the external oblique and split it, as in Bassini's hernial operation, from the external ring to a little above the internal ring. Retract the flaps of fascia thus formed.

Step 3.—Push the internal oblique muscle aside [illegible] thus

expose the inguinal canal and spermatic cord. Dissect the cord from its bed. Open the posterior wall of the inguinal canal and invade the iliac fossa.

Step 4.—The elements composing the cord become separated at the internal ring, the vas going down towards the small pelvis, the spermatic vessels and lymphatics going up towards the lumbar region, on the psoas muscle. Follow the vas deferens as far as possible towards the deep pelvis and there ligate and divide it. Cauterize its stump with pure carbolic acid or the cautery. Follow the spermatic vessels up towards the lumbar region as far as possible and there doubly ligate and divide them.

Step 5.—Beginning above at the site of division of the vas and of the spermatic vessels, separate the cord and its envelopes downwards, to a point below the external inguinal ring. By pressing on the scrotum it is easy to deliver the testicle with its envelopes through the wound and remove them together with the cord. If the scrotum is adherent to the testicle, make a liberal excision of the scrotal skin and all the structures between it and the testicle. This is done by continuing the original incision downwards and making it surround the affected area. Remember that if the scrotum is involved, the inguinal lymphatic glands may be affected and should be removed, as it is into them that the scrotal lymphatics drain.

Step 6.—Review the wound with care and attend to hemostasis. Close the wound exactly as in an operation for the radical cure of hernia.

Epididymectomy.—This operation may be done alone or vasectomy may be added to it.

Step 1.—Make an incision into the tunica vaginalis, just external and parallel to the epididymis. If the epididymis is adherent to the skin or fistulæ are present, such adherent skin and fistulæ should be surrounded by elliptical incisions and removed with the epididymis.

Step 2.—Make an incision along the junction between the epididymis and testicle on the *outer* side. This incision divides the serous membrane alone opposite the body of the epididymis,

while at the head and tail (globus major and minor) it divides the tunica albuginea. With knife or scissors separate the head (globus major) from the testicle. Next separate the body of the epididymis from the testicle (Fig. 475). As the *inner* side of the junction between the epididymis and testicle is reached, proceed with great care, because here the vessels going to the testicle are in contact with the epididymis. By making slight traction and putting the structures of the cord gently on the stretch, it becomes easy to separate the epididymis from the vessels.

FIG. 475.—(*Monod and Vanverts.*)

Step 3.—The epididymis being free, continue the dissection by separating the vas from its surroundings up to the internal ring, "where it is grasped on both sides of its circumference with hemostatic forceps, divided, and the lumen of the proximal end cauterized with 95 per cent. carbolic acid in the end of a needle. The needle is to be worked upwards in the lumen for one-half inch and the mucous membrane thoroughly cauterized." Ligate the proximal end of the vas. This is important in that it prevents infectious material being voided from the vas into the tissues.

Step 4.—Review the wound made in the testicle by the removal of the epididymis. If any foci of disease are found, excise them by wedge-shaped incisions and close the wounds with fine catgut. Suture with catgut any wound in the tunica albuginea. If the condition of the testicle makes one suspect disease in it, it is proper to make an exploratory incision into it. Such incisions must be closed with catgut sutures.

Step 5.—Having attended to hemostasis, close the external

wound with sutures. It is well to provide drainage for twenty-four or forty-eight hours.

In some cases it is possible to remove disease from the epididymis by partial or complete excision of that organ, without removing so much of the vas as was recommended in the preceding paragraphs. When this is possible, one may follow the suggestion of Bardenheuer, which was first carried out by Rasumowsky ("Archiv f. klin. Chir.," lxv, p. 557), viz., to make an anastomosis between the vas and the *rete testis* or the remnants of the epididymis.

Anastomosis between the Vas Deferens and the Rete Testis.—*Step* 1.—Completely excise the epididymis, removing as little of the vas deferens as possible.

Step 2.—Pass a fine probe or director into the vas and with this as a guide split the vas for a little less than half an inch.

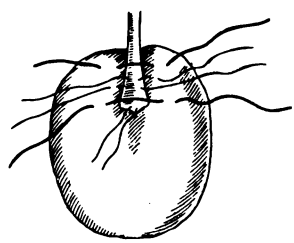

FIG. 476.

Step 3.—With fine catgut sutures, introduced in the Lembert fashion, unite the gaping end of the vas to that part of the testicle from which the head of the epididymis was removed (rete testis, beginning of the coni vasculosi).

Step 4.—Partially bury in the testicle the site of anastomosis, by means of a few heavy sutures introduced in the Lembert fashion (Fig. 476).

Step 5.—Cover the line of sutures in the testicle by closing with catgut the wound in the tunica vaginalis, etc. Close the skin-wound.

Anastomosis between the Vas Deferens and the Epididymis after Partial Excision of the Latter.—*Step* 1.—Excise the tail and part of the body of the epididymis, dividing the body transversely.

Step 2.—Split the vas for about ½ inch, and introduce into it (in the Lembert fashion) two fine catgut sutures.

Step 3.—Perforate or tunnel the remaining portion of the epididymis (head and part of body) with a pointed knife introduced through its cut surface. Through this tunnel pass, by means of needles, the catgut sutures attached to the vas (Fig. 477).

Step 4.—By pulling on the catgut threads insinuate the open end of the vas into the tunnel and fix it there by tying the catgut sutures. One or two extra sutures may be used to complete the union.

Step 5.—Close the wound in the overlying tissues by one or more layers of catgut sutures.

Excision of the Vas Deferens with or without the Seminal Vesicle: Vasectomy.—The term "vasectomy" is properly applied to this operation, but custom seems to have limited its use to the mere division or removal of a small segment of the vas in cases of prostatic hypertrophy. Vasectomy, in the latter limited sense, is performed by incising the skin immediately below the external abdominal ring, exposing the cord, separating the vas from the other structures of the cord, and dividing it between two ligatures. J. W. White and R. Harrison have found much benefit result from this simple operation. Vasectomy, in the wider and proper sense of the term, is a much more serious procedure—so difficult, indeed, that a number of operators have discarded its use. Vasectomy may be *partial* or *complete*.

FIG. 477.

Partial Vasectomy.—The scrotum has been opened and the testicle or the epididymis has been excised. The divided end of the vas (if not still attached to the testis or epididymis) is seized in forceps to prevent its retraction. Continue the skin-incision upwards and outwards. Open the inguinal canal by incising the aponeurosis of the external oblique. Separate the vas from the cord up to or within the internal abdominal ring.

Doubly ligate the vas at as high a point as possible and divide it, being careful to cauterize the stump. Attend to hemostasis and close the wound. In many cases this partial operation suffices.

Von Büngner, instead of excising the vas as above, merely follows it to the external abdominal ring and endeavors to remove the rest of it by avulsion, in the same manner as Thiersch extracts nerves. This method might be practicable if the vas to be removed was sound, but it is diseased and gives way at its weakest point, which is a diseased point. Theoretically, the method is bad.

Complete Vasectomy with or without Excision of the Seminal Vesicle.—Baudet and Duval have systematized this operation very thoroughly. Place the patient in Trendelenburg's position. Excise the testis or epididymis.

Step 1.—Continue the scrotal wound up to the external abdominal ring and along the inguinal canal to a point two finger-breadths internal to the anterior superior iliac spine.

Step 2.—Open the inguinal canal by incising the aponeurosis of the external oblique. Divide the internal oblique and transversalis along the line of the skin-incision. Divide the transversalis fascia *without injuring the peritoneum.*

Step 3.—With the finger strip the peritoneum off the iliac fossa. Do *not* strip off any of the fascia with the peritoneum. It is important to keep between these two structures.

Step 4.—Incise the sheath of the spermatic cord and look for the vas beside the pubic spine. With blunt dissection follow and isolate the vas first towards the iliac fossa and then on the peritoneum, which is retracted inwards by a wide retractor. Do *not* exert any traction on the vas. Use the eye rather than the finger as a guide. During this dissection retract the epigastric artery forwards, the umbilical downwards and outwards. As the wound becomes deeper carry out the dissection with forceps. When a point deep down in the pelvis is reached, note a "tent-like" ridge passing transversely inwards from the pelvic wall. This is composed of the vesicular vessels covered by aponeurosis, and here the vas deferens enters the vesicular space. If the operation

is to consist of complete vasectomy alone, doubly ligate the vas, divide and remove it. If it is desired to remove the seminal vesicle, proceed to Step 5.

Step 5.—Make a transverse tear in the fascia covering the vesicular vessels. Retract the edges of the fascial wound. Doubly ligate and divide the vessels. Beneath the vessels lies the pale, rather sinuous seminal vesicle.

Step 6.—Seize the base of the vesicle with a clamp and isolate it from its sheath, being careful, during the dissection, to keep in close contact with the vesicle so as to avoid hemorrhage. The deep portion of the vas is easily separated from the peritoneum and bladder; it lies along the inner side of and is closely attached to the vesicle.

Step 7.—With scissors separate the vas and seminal vesicle from the prostate. Cauterize the stump.

Step 8.—The most of the huge wound promptly closes itself as soon as the retractors are removed. It is well to place a cigarette drain into the depth of the wound. Close the wound in the parietes in the same fashion as in the radical cure of hernia.

Young's Operation.—("Annals of Surgery," Oct., 1900, and Nov., 1901.) "Suprapubic retrocystic extraperitoneal resection of the seminal vesicles and vasa deferentia." In several cases Young has successfully performed this most difficult operation, and has at the same time excised portions of the urinary bladder.

Make a vertical median incision from the pubis to a point above the umbilicus. At the upper end of this make a transverse incision dividing both recti muscles. These incisions penetrate to but do not involve the peritoneum. Retract the edges of the wound. Beginning below, dissect the peritoneum from the anterior bladder-wall up to and including the vertex of the bladder. At the vertex the separation is difficult. Continue the separation down the posterior bladder-wall until the seminal vesicles and vasa deferentia are exposed. Remove these, and with them any diseased portions of the prostate and bladder. (Young has removed about one-half of the bladder.) Close the bladder wound by sutures. Provide for drainage. Close the abdominal wound.

Several methods have been devised for the exposure and removal of the seminal vesicles through the perineum. These are so similar to some of the methods described for the exposure of the prostate that they need not be dilated upon. Schede has used the sacral and parasacral routes to reach the seminal vesicles, but other routes seem as efficient and much less formidable.

Remarks on Castration, Epididymectomy, Vasectomy, and Vesiculectomy.—In cases of malignant disease of the testicle or epididymis it is necessary to abide by the rule, do too much rather than too little. The freest possible excision of all tissue which may possibly be infected is compulsory, whether that tissue shows any signs of disease or not. Only by conscientiously working along the lines of thoroughness can improved results be obtained. When the disease necessitating operation is tuberculosis, no such "hard-and-fast" rules meet with universal approval. König more than any other surgeon has advanced our knowledge of the surgery of tuberculosis, and hence his opinion ought to carry great weight. This surgeon, and with him Kocher, Terrilon, Senn, etc., declares in favor of castration (orchidectomy) in cases of tuberculosis suitable for operation. When epididymectomy is performed, it is feared that tuberculous foci may be left in the testicle and cause further trouble, and it is assumed that no useful function can be performed by the imperfect organ left behind. J. B. Murphy, Tillaux, and others draw attention to the fact that the testicle has a useful influence on the general metabolism which must not be disregarded. The glandular portion of the testicle is practically never primarily and rarely secondarily affected to a serious extent. The results of Bardenheuer and Murphy show that epididymectomy is as curative as is castration. In suitable cases it may be well to attempt anastomosing the vas to the testicle. Bogoljuboff's experiments ("Archiv f. klin. Chir.," lxxii, p. 449) show that this operation does actually provide direct communication between the tubules of the testicle and the vas. The status of the operation is, however, by no means fixed as yet.

J. B. Murphy considers epididymectomy contraindicated (1)

where there are extensive tubercular lesions elsewhere which will shortly terminate the patient's life. (2) Where the disease has extended to and destroyed the greater part or all of the testis proper. Here castration should be done. (3) Where the scrotum is riddled with discharging sinuses. The indication is usually here also for castration. Apart from these three conditions, in every case a resection, typical or atypical, should be done. Murphy also points out that after epididymectomy (without anastomosis) "sexual desire and potency, even to emissions, are retained; power of procreation, however, is lost."

Horwitz comes to conclusions which are very similar to and support those of Murphy.

In a large number of cases in which there has been evidence of involvement of the vas, seminal vesicle, and even bladder, simple epididymectomy, with or without any extensive vasectomy, has given excellent results. In these cases it appears as if nature was able successfully to combat the secondary lesions when the primary one was eliminated. The profound influence exerted on the prostate, etc., by castration or epididymectomy probably effectually aids nature in her combat.

When the gravity of operations for complete vasectomy and vesiculectomy is considered, and the frequency with which all evidences of disease disappear from the neck of the bladder after simple epididymectomy and partial vasectomy, it appears wise to be conservative. Young's advice is excellent, viz., to abstain from operations on the seminal vesicles and prostate until such time as it is demonstrated that removal of the testicular foci has failed to arrest the progress of the disease in these organs and it has spread to the bladder. According to Young, serious involvement of distant parts, pulmonary, urinary, osseous, etc., does not contraindicate operation. Removal of the local lesions often has a very satisfactory effect on the distant foci.

Operative Treatment of Undescended and Misplaced Testicle.—There are several types of undescended and misplaced testicle. The testis may be situated (*a*) in the abdomen near its original position; (*b*) at the internal ring; (*c*) in the in-

guinal canal; (*d*) outside the external ring; (*e*) in the perineum; (*f*) on the thigh below Poupart's ligament.

No matter where the testis is located, the principles of treatment are identical. These principles are: (1) Proper exposure of the organ. (2) Thorough relief of tension so that the organ may be brought into the desired place (the scrotum) and may tend to stay there of itself. (3) Proper preparation of the bed in which the testis is to lie. (4) Selection of proper time for operation. Undoubtedly the changes incident to puberty will take place more completely in the testicle when it lies in its natural position in the scrotum; hence the age of selection for operation is before puberty, when the patient is from six to twelve years old.

A. D. Bevan ("Jour. Am. Med. Assoc.," Sept. 19, 1903) has thrown much light on the condition under discussion, and the following paragraphs are based on his writings:

(A) The testicle is in the inguinal canal or outside the external ring.

Step 1.—Make an incision from the external ring upwards and outwards for a distance of three inches. This incision is like that made in Bassini's operation for inguinal hernia and does *not* involve the scrotum. Divide and retract the aponeurosis of the external oblique as in the hernia operation. Divide the cremasteric and thin transversalis fascia throughout the length of the wound.

Step 2.—Note the peritoneal pouch containing the testicle. Open this pouch and expose the testicle. Divide the peritoneum above the testicle and carefully separate it from the cord, as in a hernia operation. Close the stump of peritoneum by suture or ligature. With a purse-string suture close the portion of peritoneal sac in contact with the testicle and so form a tunica vaginalis (Fig. 478).

Step 3.—Lift the testicle out of its bed. Pull gently on the cord to lengthen it as much as possible. Shortened bands of connective tissue will be seen as tense bands in the cord. Tear through these bands with forceps. Strip the cord of all the surrounding fascia, leaving nothing but the vessels and the vas. Separate the sper-

PART V.—THE EXTREMITIES.

CHAPTER I.

DUPUYTREN'S CONTRACTURE AND DUCHENNE-ERB PARALYSIS.

DUPUYTREN'S CONTRACTURE.

Dupuytren's contracture is due to a contraction of the palmar fascia whereby the fingers become fixed and incapable of extension. The ring finger is first affected. The fascia is normally connected by bands with the skin of the palm. When the fascia contracts, the skin, being adherent to it at points, is naturally thrown into wrinkles and folds. Operation is indicated when the deformity causes distinct disability. In a handicraftsman operation will be called for at a much earlier stage of the disease than in one whose work does not demand free use of the hands.

Adam's Operation.—Clean the hand thoroughly. Note the points where the skin is *not* closely adherent to the subjacent fibrous band. At such places introduce a fine tenotome between the skin and the fibrous band. Turn the edge of the tenotome against the fibrous band. Make the band tense by extending the affected finger, and at the same time give a slightly sawing motion to the tenotome. Be careful *not* to cut too deeply lest the flexor tendons be injured. The operation must be repeated at several points. Apply aseptic dressings. Fix the hand and fingers in a position of extension by means of a dorsal splint. After the lapse of three weeks careful and throrough massage is indicated; the splint may be discarded during the day, but a suitable appliance to maintain extension must be worn at night for several weeks.

Recurrence of the trouble often takes place, but in other cases the result is permanent and various nodes of scar tissue or callosities disappear in a surprising manner. The operation is simple, can be performed under local anæsthesia, and ought to be tried in most cases before more severe measures are adopted.

Dupuytren's Operation.—Cleanse the hand thoroughly. Extend the affected finger as much as possible. Make a transverse incision one inch in length opposite the metacarpophalangeal joint. This incision divides both the skin and the contracted fascia, but *must not* injure the flexor tendons. Apply aseptic dressings. Fix the hand and fingers in a position of extension by means of a suitable splint. When the wound has healed, the treatment to be adopted is the same as after the Adam's operation.

Open Operation; Hardie's Operation.—"An incision is begun half an inch above the principal transverse fold of the palm, immediately over the tense bridle of fascia, proceeding to the finger mainly involved. This is carried along the bridle to a little beyond the base of the last phalanx which is affected. The lips of the incision having been opened up, the knife is then carried close to bridle along its whole extent, so as to separate from it the adjacent skin, cellular tissue, and fat, first on one side and then on the other. In doing this it is necessary to go some depth near the upper end of the incision, so as to divide the little bands which attach the web of the finger to the processes of fascia inserted into the sides of the first phalanx." Cut across the tense fascia at the digital end of the incision. Make further transverse incisions opposite the middle of the first and second phalanges as may be required. Divide the fascia transversely wherever it seems to prevent complete extension of the fingers. Isolated portions of fascia *may* be removed if convenient. Close the wound with sutures after attending to hemostasis. Apply aseptic dressings and bandage to a straight splint. After the wound has healed, make use of massage and retain the splint for two or three weeks.

Excision of the Diseased Fascia.—Complete excision of the

diseased fascia is impracticable, but an extensive excision is both practicable and beneficial. Several methods of operating have been devised. Some surgeons advise the formation of a V-shaped flap having its base towards the fingers; others advise a straight longitudinal incision over the most prominent cicatricial band. Each method is proper in suitable cases. Whichever incision is used, the scar tissue is exposed as completely as possible by reflecting the skin in the manner described in Hardie's operation. The cicatricial tissue is divided at its insertion into the phalanges, carefully dissected from the subjacent structures, and removed if possible in one piece. Hemostasis is attended to and the wound closed. If the V-shaped incision has been used, the flap thus formed will generally be found incapable of completely filling the bed from which it was removed, so that it is necessary to close the proximal end of the wound as if it was a linear incision. The resulting scar is Y-shaped.

J. D. Griffith excises the cicatricial tissue through a longitudinal incision as described above, but instead of at once closing the wound, he adopts the following procedure: From the end B (Fig. 481) of the longitudinal incision A B he makes the curved incision B C through the skin, and thus forms the flap F, with its base at A C. In the same manner he makes the flap E, having its base at A C. These flaps are reflected from the subjacent tissues and turned so that the end of the flap E covers the raw surface left by the reflection of the end of the flap F, and the end of the flap F covers the raw surface left by the reflection of the end of the flap E (Fig. 481). Whether the transposition of the skin-flaps is of much value or not, the method has given good results in the hands of Griffith, and in one case in which the author used it the result seemed excellent. In most cases, however, any attempts to transpose skin-flaps is unwise, as the skin is so thin and ill-nourished that death of the flaps is very likely to ensue.

Lotheissen's Operation.—("Centralblatt f. Chir.," 1900, No. 30.) Make the curved incision A, B, C (Fig. 482). Reflect the palmar flap thus outlined. Excise the palmar aponeurosis.

Extend the fingers. Replace the flap. With the fingers extended there will be a small defect (A B) where the edges of the wound do not come together. Apply sutures as shown in the figure. The Esmarch bandage is used to permit of bloodless, careful dissection. Before the flap is replaced, hemostasis must be most carefully attended to, as a subcutaneous hematoma or the application of a compressive dressing endangers the vitality of the flap.

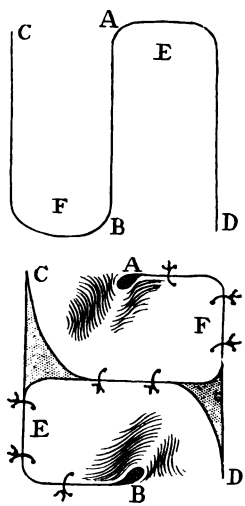

FIG. 481.

FIG. 482.

DUCHENNE-ERB PARALYSIS.

Paralysis of certain groups of muscles and anæsthesia of various regions may result from injuries to the brachial plexus. These injuries may be due to tearing, stretching, or compression of the plexus during birth (Duchenne) or to trauma received later in life. The part of the plexus affected is at that point where the anterior primary divisions of the fifth and sixth cervical nerves unite. The motor fibres in these two nerve roots supply the deltoid; supraspinatus and infraspinatus; biceps; brachialis anticus; supinator longus and brevis, and the teres minor. Thus in a

typical case of Duchenne-Erb paralysis the arm cannot be abducted at the shoulder, flexion of the elbow is impossible, the forearm is in a position of pronation, the whole arm is rotated outwards to such an extent that the palm of the hand may be directed outwards.

Wilfred Harris and V. W. Low ("Brit. Med. Jour.," Oct. 24, 1903) believe that Markoe's case ("Annals of Surg.," 1885, ii, 185) of division of the fifth cervical root proves that the deltoid, spinati, biceps, and brachialis anticus derive their *whole* motor supply from this source, while the supinator longus is, at least in part, indebted to it for its motor impulses.

When a case presenting the symptoms enumerated shows no improvement after two or more months of treatment by electricity, massage, etc., but, on the contrary, the electrical reactions of degeneration begin to appear, then operative treatment becomes proper. There are two methods by which improvement may be attained—one direct, the other indirect.

(A) Direct Method.—*Robert Kennedy's Operation.*—("Brit. Med. Jour.," Feb. 7, 1903.) Place the patient on his back, with a pad under the shoulders to permit of the head being well thrown back. Incline the head and face to the opposite side.

Step 1.—From the junction of the middle and lower thirds of the outer margin of the sterno-mastoid make an incision outwards and downwards to the junction of the outer and middle thirds of the clavicle. Divide the deep fascia between the sterno-mastoid and trapezius. Expose the omo-hyoid below the lower edge of the wound. Above the omo-hyoid expose the scalenus anticus muscle and demonstrate the nerve-trunks emerging from under it. Trace the two upper nerve-trunks outwards to their junction.

Step 2.—Having found the junction of the fifth and sixth nerves, recognize the various branches and free them from adhesions. Free the main trunks from the adhesions which seem to be always present.

Step 3.—Note the condition of the isolated nerve. Kennedy has always found it to be in a hopelessly cicatricial condition. If

the whole nerve seems to be composed of scar tissue, divide the fifth and sixth above the diseased area. The cut surface ought to show a healthy appearance; if not, slice off more of the nerve until healthy tissue is reached. Pull the diseased area inwards and put on the stretch the three peripheral divisions of the nerve, viz., the supra-scapular nerve, the branch to the outer and that to the inner cord of the plexus. Divide these three branches at points beyond the disease, the section being made through healthy nerve.

Step 4.—Suture the three peripheral stumps to the two proximal stumps of nerve by means of fine chromicized catgut threads. Before approximating the divided nerve ends and tying the sutures push the shoulder upwards and incline the head to the side being operated upon. This relieves tension and permits of approximation.

Step 5.—Close the external wound. Apply dressings. With plaster-of-Paris or a suitable apparatus keep the shoulder elevated and the head inclined to the side on which operation has been performed, and, above all, prevent motion of the head on the shoulders.

After two weeks the fixed dressings may be discarded. Kennedy does not advise any special after-treatment, believing that the nervous impulses, which can now reach the muscles, will lead to their satisfactory development. Most surgeons will undoubtedly endeavor to assist recovery by the use of electrical stimulation and massage.

Harris and Low think that Kennedy relies too much on the physical appearance of the nerves when exposed, and as a consequence may be led to excise too much. Thus, if the deltoid, spinati, biceps, and brachialis anticus muscles (and perhaps also the supinator longus) are paralyzed, and if Markoe's observation be remembered, then after exposing the nerves it would be wise separately to stimulate faradically the fifth and sixth nerves. If stimulation of the fifth fails to gain response while stimulation of the sixth does, then these observers advise that the fifth nerve be followed upwards, be divided well above the junction, and the

proximal end of its peripheral portion be anastomosed to a split in the side of the sixth nerve. Part of this advice does not appeal to the author, as there seems to be little advantage to be gained by it, in that the portion of the fifth nerve grafted on to the sixth has been proved to be incapable of conduction.

Undoubtedly Harris and Low are right in advising the use of electrical tests before excising portions of the nerve, as by this means nerve tissue may be saved which would otherwise be destroyed. The benefit of analytical observation during operation is shown by a case in which Harris and Low made use of cross-union. The case was one of atypical Duchenne-Erb palsy:

A girl, aged two years, had suffered a few months before from "infantile paralysis or acute anterior poliomyelitis of the right shoulder," leaving behind paralysis and wasting, with reaction of degeneration in the deltoid, supraspinatus, and infraspinatus muscles. The biceps, brachialis anticus, and supinator longus were only slightly affected. From dissections and experiments on monkeys Harris and Low concluded that the "circumflex" bundle of nerve filaments occupies the upper half of the fifth root. In the case under discussion they made a longitudinal split in the fifth root, found that the faradic stimulation of the upper segment of the nerve gave the very slightest contraction of the biceps with definite weak contractions of the deltoid and triceps, while stimulation of the lower half gave powerful contractions of the biceps, causing strong flexion of the forearm, with no contractions at all in the deltoid. This being so, the "upper half of the nerve was formed into a flap having its base below (at the junction of the fifth and sixth roots) and the free end of the flap was anastomosed to a split made in the side of the sixth root."

Operations such as this one of Harris and Low have not yet stood the test of time, but their possibility and plausibility make them deserving of attention. In one of his cases Kennedy had a most gratifying result.

(B) **Indirect Method.**—*Tubby's Operation.*—("Brit. Med. Jour.," Oct. 17, 1903.) In some cases satisfactorily treated by

Tubby no attempt was made to repair the damaged nerves, but disability was relieved by means of muscle transplantation or grafting. The operation is performed in two sittings:

(*a*) *Restoration of Elbow Flexion.—Step* 1.—Make an incision four to six inches long, from the middle of the back of the upper arm downwards and forwards towards the front of the elbow. and following the course of the musculo-spiral groove.

Step 2.—Expose and draw aside the musculo-spiral nerve. Demonstrate the outer part of the triceps muscle which arises above and to the outer side of the musculo-spiral groove. Detach a wide strip of the outer part of the triceps from its tendon, and separate it upwards for three to four inches, leaving this strip or flap attached to the rest of the triceps by its upper extremity.

Step 3.—Through the same incision expose the lower end of the biceps. At a point about two inches above the elbow make a tunnel through the muscle, from behind forwards. Flex the elbow to relieve tension. Pull the free end of the triceps flap through the tunnel in the biceps and fix it there with sutures.

Step 4.—Close the wound. Dress. Immobilize the elbow in a position of flexion. Do not permit any attempts at motion for one month.

(*b*) *Restoration of Shoulder Abduction.—Step* 1.—From a point one inch below the middle of the clavicle make an incision outwards to the tip of the acromion and then downwards for three inches. From the tip of the acromion make an incision upwards for two to three inches. Reflect the flaps outlined.

Step 2.—Demonstrate the clavicular portion of the pectoralis major; separate it from its attachment to the rest of the muscle; divide its insertion into the humerus, thus forming a muscular flap attached to the clavicle. Demonstrate and divide the insertion of the trapezius into the clavicle; separate the corresponding part of the muscle from the rest of the trapezius by splitting in the direction of the fibres. Thus a second muscular flap is obtained.

Step 3.—Bring the free end of the flap obtained from the pectoralis major upwards over the acromion process and fix it into the deltoid. With sutures fix a few fibres of the pectoral flap to

the tip of the acromion so as to avoid slipping. If the flap is not long enough to reach and be united to the deltoid satisfactorily, make a vertical incision through the muscle to the bone, reflect upwards a flap of periosteum (as thick and large as possible), and unite this to the end of the pectoral flap. Suture the end of the flap obtained from the trapezius to the side of the pectoral flap. The result is a new muscle composed of contributions from the pectoralis major and the trapezius, inserted into the humerus in imitation of the deltoid.

Step 4.—Close the wound. Dress. Immobilize in a position of abduction. Do not put the newly grafted muscle on stretch for at least a month. After one month begin exercises with caution. Tubby has had some excellent results from this operation.

CHAPTER II.

CLUB-FOOT (TALIPES EQUINO-VARUS).

Forcible Rectification.—The necessary force may be applied either by the hands or by the osteoclast. A glance at any osteoclast shows how it is used. Tenotomy of the tendo Achillis is usually, and of the plantar fascia frequently, a necessity immediately before the forcible rectification.

Step 1.—Grasp firmly in one hand the heel and ankle, in the other the distal end of the foot, leaving the region of the calcaneocuboid articulation unsupported by the hands. Lay the convex surface of this portion of the foot against the edge of a wedge of wood covered by a towel. The wedge acts as a fulcrum.

Step 2.—Apply force, even the whole weight of the body, to straighten or unfold the foot by compressing its convex side against the fulcrum and stretching or tearing the structures on the concave side. In young children overcorrection is often possible in one sitting. Care must be taken not to tear the skin. If the skin seems about to tear, put off further correction until another time, when it will be found to have accommodated itself to the changed circumstances. W. J. Frick avoids tearing the skin by introducing a tenotome and with it separating the skin from the subjacent fascia; when this is done *thoroughly*, he finds that the skin stretches without trouble. If the desired result is not obtained in one sitting, a second, third, or fourth operation should be done at intervals of from two to three weeks.

Before the anæsthetic is discontinued, envelop the foot in a plaster-of-Paris dressing. To avoid trouble from swelling of the foot owing to the trauma it is well to keep the limb elevated for twenty-four hours. *Remember that overcorrection is the aim.*

Phelps' Operation.—*Preliminary Treatment.*—If the patient has walked, large callosities will be present on the foot; to soften and clean these, soap poultices should be applied for twenty-four

hours, and twelve hours before the operation the foot must be thoroughly scrubbed and an antiseptic fomentation applied.

Step 1.—Render limb avascular by elevation and apply tourniquet. Place the foot, with outer side downwards, on a sand-bag. Have the assistant hold the heel firmly. Grasp the distal portion of the foot and make the plantar tissues tense.

Step 2.—On the inner side of the foot make an incision beginning directly in front of the malleolus and ending one-fourth of the distance across the sole of the foot. Divide *all* resisting struc-

FIG. 483.

tures, penetrating to the bone if necessary. (See Fig. 483; here the cut is made from the sole to the malleolus.)

Step 3.—By manipulation complete the overcorrection of the varus.

Step 4.—Correct the equinus by achillotomy.

Step 5.—Pack the wound with iodoform gauze. Dress. Immobilize, in a position of overcorrection, by a plaster-of-Paris bandage, which reaches well up the calf. While the plaster is hardening, hold the foot in its new position by means of a flat board laid against the sole

Step 6.—Remove the tourniquet. Elevate the limb for twenty-four hours.

If cleanliness has been attained, the dressings may be left untouched for from two to three weeks, when the wound will generally be found practically healed.

Tarsectomy.—Occasionally the above operation may be found insufficient to produce overcorrection. Having divided the soft parts as described, cut through the neck of the astragalus with a chisel. In packing the wound do *not* introduce the gauze into the cleft in the bone.

After-treatment.—Plaster-of-Paris, renewed when necessary, should be worn for from six to eight weeks, after which massage

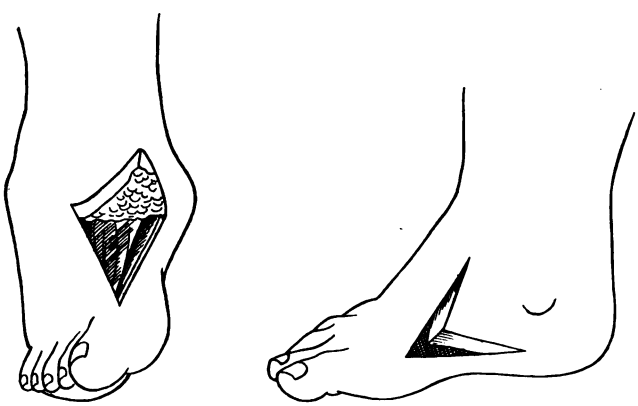

FIG. 484.—(*Jonas, "Annals of Surg."*)

and exercises should be used and a good strong shoe worn. As a rule, no special club-foot shoe is necessary after the Phelps operation.

Jonas' Operation.—A. F. Jonas ("Annals of Surg.," April, 1899) thus describes his method: "An incision is made, beginning slightly below the margin of the plantar fascia on the inner side of the foot, at a point on a line directly below and anterior to the internal malleolus, extending forwards and upwards to a point on the first metatarsal bone and nearly to the metaphalangeal articulation. A second incision is made, beginning at a point over the

astragalo-scaphoid articulation, extending forwards and slightly downwards, joining the first incision near the metatarso-phalangeal joint, forming a **V** (Fig. 484). The incisions are made deep, so as to include the subcutaneous tissue and fat." Dissect back the flap thus outlined. Sever *diagonally* the inner fasciculus of the plantar fascia. Divide the remaining structures successively, as directed by Phelps. Do not injure the astragalo-scaphoid capsule. Make another incision on the outer side of the foot over the head of the astragalus, and with a chisel divide the neck of that bone, if necessary, removing the head. Overcorrection is now easy. Ligate bleeding points. Replace the triangular flap (Fig. 484). Do *not* suture. Cover the wound with perforated oiled silk. Dress. Immobilize in a plaster-of-Paris bandage which reaches one-third up the thigh. Leave the dressings undisturbed for five or six weeks.

This method is only suitable in "old, inveterate, and relapsing cases."

Lorenz (König, "Lehrbuch der speciellen Chir.," iii, 809) gives the following list of operations for club-foot, in which the bones are attacked:

(A) Osteotomies.
  (1) Linear division, navicular bone from the sole (Hahn).
  (2) Linear division, tibia and fibula above the ankle.

(B) Enucleation.
  (*a*) Of one bone:
    (3) Of the cuboid (Solly).
    (4) Of the astragalus (Lund, Mason).
    (5) Of the astragalus with resection of the point of the external malleolus (Mason, Ried).
    (6) Curettement of the spongy part of the astragalus, leaving the articular surfaces intact (Verebély).
    (7) Of the astragalus plus removal of a wedge with base external from the anterior process of the calcaneum (Hahn).

Meussel's operation of extirpation of ossifying centres of the astragalus in young children.

  (*b*) Of several bones.
    (8) Enucleation of astragalus and cuboid (Hahn, Albert) and of the navicular bone (West).

(9) Enucleation of the navicular and cuboid (Bennet).

(C) Resections.

(10) Of the head of the astragalus (Lücke, Albert).

(11) Of a portion of bone from the external half of the neck of the astragalus (Hueter).

(12) Resection of a wedge from the outer and upper sides of the tarsus (O. Weber, Davies Colley, R. Davy, Schede, Meussel, etc.).

(13) Resection of two wedges perpendicular to each other with their bases directed outwards from the astragalo-calcaneal and Chopart's joints (Rydygier).

Occasionally the fibula occupies a position too far back near the tendo Achillis, the space between the internal and external malleoli is too narrow, and the anterior portion of the astragalus is too wide. This state of affairs is an indication for excision of the astragalus. (König.)

Astragalectomy.—1. Apply an Esmarch bandage.

2. Make a longitudinal, slightly curved incision two inches long over the most prominent part of the head of the astragalus from the external malleolus downwards and inwards, between the outermost tendon of the extensor longus digitorum and the peroneus tertius. Reflect the soft parts with a periosteal elevator.

3. Open the ankle and astragalo-scaphoid joints. Seize the bone with a lion-forceps, loosen it with an elevator, and divide its ligaments with strong, blunt-pointed scissors or the scalpel.

4. Place the foot in good position. If correction cannot yet be obtained, one may follow Walsham's advice (Jacobson's "Operations of Surg.," ii, 711): "When once a bone-operation has been embarked on, it is no use stopping short till sufficient bone has been cleared away to permit of the rectification of the foot. No more should, of course, be removed than is necessary, but to take away too little is to my mind much the graver fault."

The operation of cuneiform tarsectomy consists in making a longitudinal incision over the most prominent portion of the tarsus, without injury to the tendons, in reflecting the soft parts to lay bare the bone, and in excising a wedge of bone. The steps of the operation do not require description; the surgeon must

apply Walsham's rule, quoted in the previous paragraph, and also make use of common sense.

Ogston's Operation.—("Brit. Med. Jour.," June 21, 1902.) This operation is similar to that of Meussel, and is suitable in bad cases of club-foot in children up to the sixth or possibly the eighth year. A skiagraph will tell if ossification has proceeded too far. The principle of the operation is to remove the osseous centres from those bones which impede rectification. After correction the remaining envelope of cartilage will become ossified. "An incision through the skin is made in a gentle curve beginning in front of the external malleolus and extending forwards, with its convexity towards the sole, until it terminates over the calcaneo-cuboid joint on its dorsal aspect. When its edges are retracted, the outline of the astragalus is visible. The soft parts covering it and the cartilaginous shell surrounding its osseous centre are then divided by a shorter incision in the same line as the cutaneous one, the knife being made to sever everything down to the bony kernel. A Volkmann's spoon, slightly curved forwards at its neck, is passed into the wound of the cartilage, and its whole bony centre, save the upper part constituting the pulley between the two malleoli, is cautiously scraped out." If necessary, the same treatment may be applied, through the same external wound, to the cuboid and anterior end of the os calcis. After removing the Esmarch constrictor and attending to hemostasis, close the wound with deep and superficial sutures and immobilize with plaster-of-Paris in correct position.

Tendon Transplantation.—In paralytic club-foot correction of the bony deformity may be sufficient, but occasionally it is necessary to reinforce the muscles whose weakness caused the deformity. Paralysis of the extensor digitorum and the peronei muscles permits adduction, supination, and plantar flexion. The extensor is not merely an extensor (a dorsal flexor), but is an important pronator as well (*i. e.*, it holds up the inner side of the foot).

After recovery from thorough correction of the bony deformity the first aim is to strengthen the extensor digitorum, the second

to reinforce the two peronei muscles. These latter may be strengthened from the same source, as they act synchronously. The after-treatment consists in exercise. Appropriate apparatus must be worn for a time to prevent elongation of the united tendons. The technique of tendon transplantation is described in another chapter.

Examples (Vulpius, "Die Sehnenüberpflanzung" p. 146):

1. M. M., nine years. Paralysis in first year. Talipes equino-varus slowly developed. Paralysis of extensor digitorum alone. *Operation:* Correction of the deformity. One-half of tibialis anticus transplanted to ext. digitorum. Recovery. *Result:* After four and a half years position normal, foot movable in all directions.

2. L. M., twenty-seven years. Paralysis began in third year. Talipes equino-varus slowly developed. Very painful callus on back of foot. Walking only possible in an apparatus. *State of muscles:* Tib. ant. degenerated in streaks. Ext. hallucis and gastrocnemius in good condition, ext. digitorum and peronei completely paralyzed. *Operation:* After instrumental correction, a slip or flap from tendo Achillis was united to the peronei. The rest of the tendo Achillis was elongated by a plastic method. A part of the tib. ant. and of the extensor hallucis were united to the ext. digitorum. The tib. ant. was shortened. Recovery. *Result:* In four months the foot was in good position with but limited motion. After two and three-fourth years position was still good and limited motion possible in all directions. Walking was good in ordinary shoes. The man is a laborer and can work all day.

CHAPTER III.

FLAT-FOOT.

Ogston's Operation.—Apply Esmarch's bandage. On the inner side of the foot make an oblique incision in such a manner that the middle of the cut crosses the astragalo-scaphoid articulation. With a periosteal elevator expose those portions of the head of the astragalus and the scaphoid which are contiguous to the joint. With a chisel remove sufficient of these bones (especially of the astragalus) that when their cut surfaces are approximated the sole of the foot is arched in the normal fashion. Ogston maintains the bones in apposition by means of bone pegs; this is perhaps unnecessary. Close the wound without drainage. Dress. Immobilize with plaster-of-Paris. Place limb in elevated position. Remove Esmarch's bandage. Treat the case as a fracture.

Müller's Operation.—("Centralblatt f. Chir.," 1903, p. 40.) In flat-foot, especially when muscles are spastic, the tibialis anticus tendon often stands out like a cord and its site is marked on the skin by a pigmented line. The object of Müller's operation is forcibly to correct the position of the foot and to retain the new position by means of the anterior tibial tendon. In 13 cases the operation gave satisfactory results.

Step 1.—Tenotomy of tendo Achillis to permit elevation of arch of foot.

Step 2.—From a point below and behind the internal malleolus, midway between it and the sole, make a curved incision along the margin of the arch of the sole to the base of the first metatarsal bone.

Step 3.—Find and divide the insertion of the tibialis anticus at the anterior end of the wound. Isolate the tendon up to the ankle.

Step 4.—Expose the plantar surface of the navicular bone and bore a hole, the size of a lead-pencil, through it from below upwards and slightly backwards.

Step 5.—Pull the tendon of the tibialis anticus through this bone tunnel by means of a thread.

Step 6.—Push the arch of the foot forcibly upwards. Pull the tendon strongly down and wind it around the inner margin of the navicular bone. Fix the tendon to the bone or periosteum with wire sutures. Close the wound without drainage. Dress. Immobilize in plaster-of-Paris for four weeks, after which massage and passive movements are begun. The "flat-foot sole" should be used until there is complete functional recovery.

According to Vulpius ("Die Sehnenüberpflanzung"), weakness or paralysis of the tibialis anticus and posticus and of the gastrocnemius is the principal cause of paralytic flat-foot (pes abductus pronatus). The appropriate treatment therefore consists, first, in overcorrecting the existing deformity; and, second, in preventing recurrence by strengthening the affected muscles, and if necessary shortening their tendons. The after-treatment includes exercise of the adductors, supinators, and dorsal flexors; and the use of an articulated support to the sole until sufficient muscular strength is developed. One example of Vulpius' method of treatment will suffice:

K. K., four years. Paralysis in second year. Marked equinus and flat-foot. Tib. ant. and post. completely paralyzed. The other muscles in good condition. Shortening of the Achilles and peroneal tendons. *Operation:* Rectification of deformity. Tenotomy of tendo Achillis. Transplantation of peroneus longus on to tibialis posticus, of the extensor hallucis and a good portion of the ext. digitorum on to the tibialis anticus. *Result:* After two months foot was in good position and all movements possible. After one year adduction and supination could be carried out with power.

CHAPTER IV.

HALLUX VALGUS AND METATARSALGIA.

HALLUX VALGUS.

Hallux valgus consists in an inward* deviation of the great toe, the last phalanx of which may lie transversely across the second toe. The head of the metatarsal bone is pushed outwards, is usually enlarged, and part of its articulating surface is no longer apposed to that of the phalanx. Between the bone and skin there is a bursa formed which frequently becomes inflamed (bunion).

Barker's Operation (Metatarsal Osteotomy).—Support the outer side of the foot on a sand-bag.

Step 1.—Make an incision directly to the bone, about one inch long, over the prominence of the metatarsal head, on the inner side of the foot.

Step 2.—With a chisel divide the metatarsal bone transversely at a point about one-half inch from the head. If the deformity is great, instead of simply dividing the bone, excise a wedge from it.

Step 3.—Straighten the toe. Apply dressings. Immobilize.

Hueter's Operation (Metatarso-phalangeal Arthrectomy).—*Step* 1.—By manipulation locate the metatarso-phalangeal joint. Make a longitudinal incision on the inner side of the foot sufficient to expose the joint and the immediately adjoining bones.

Step 2.—With a chisel shave off sufficient of the articular ends of the metatarsus and phalanx until correction of the deformity is easy.

Step 3.—Close the wound. Apply dressings. Immobilize in correct position.

* The word "inward" is used in relation to the middle line of the foot.

Robert F. Weir's Operation.—On the inner side of the foot make a longitudinal curved incision beginning "in front at the hollow of the phalanx (Fig. 485), running downwards towards the sole, and encroaching but slightly on it, and passing backwards and upwards to the middle of the metatarsal bone." Reflect the flap thus outlined. With a chisel or bone forceps excise such portions of bony exostosis as prevent reduction of the deformity. Freely divide the inner* side of the joint capsule (*i. e.*, the side next to the second toe). If the sesamoid bones are dislocated outwards, remove them. Divide the dorsal tendon near its insertion and suture it to the periosteum at the outer* side of the base of the

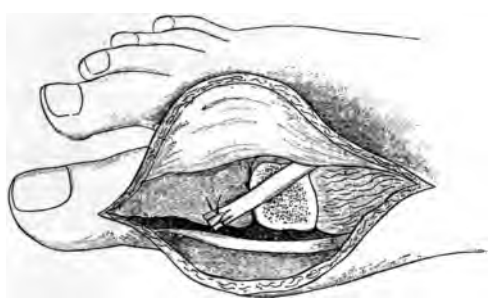

FIG. 485.—(*Weir, "Annals of Surg."*)

first phalanx. Close the wound. For two or three weeks keep a pad of gauze between the great and second toes to help hold the replaced toe in position. In the hands of Weir the above operation has given excellent results. Weir remarks: "No operation for the hallus valgus is well done that does not, before suturing, allow the toe to rest easy in its restored position. If any tilting then exists, its cause must be investigated and removed or an imperfect result will ensue."

Whatever operation is chosen,—and the author considers Weir's by far the best,—any inflamed or enlarged bursa existing over the osseous deformity must be excised.

* The words "outer" and "inner" are used in relation to the middle line of the foot and not of the body.

METATARSALGIA.

[Morton describes metatarsalgia as a painful affection of the plantar digital nerves, directly caused by pressure upon or pinching of them by certain portions of the metatarso-phalangeal articulations, especially the fourth.]

Morton's Operation.—*Step* 1.—Make a dorsal vertical incision, about two inches long, beginning over the proximal interphalangeal joint and continued over the metatarso-phalangeal joint in the middle line of the toe.

Step 2.—Expose and divide the extensor tendon of the toe. With the knife expose the bones throughout the whole length of the external incision. With blunt dissection and scissors separate the soft structures from the articulation.

Step 3.—With narrow-bladed bone forceps or with a chisel remove the articulating ends of the metatarsus and phalanx.

Step 4.—Expose and divide the flexor tendons of the toe.

Step 5.—Attend to hemostasis. Close the wound. Apply dressings in such a manner that the toe will be held in proper position during healing.

CHAPTER V.

TENOTOMY.

There are two methods of performing tenotomy: (A) The open operation; (B) the subcutaneous operation.

(A) **Open Operation.**—Make an incision of sufficient length to expose the parts to be divided. Usually this cut is made parallel to the tendon. Isolate, by blunt and sharp dissection, the segment to be divided. Retract surrounding structures. Sever the tendon. Close the wound. If it is impossible or improper to isolate the offending structure, expose it by retracting the edges of the superficial wound, and then make the section, cautiously and with small cuts, under guidance of the eye.

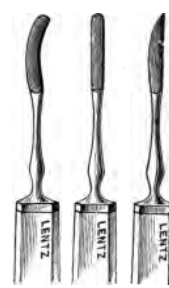

FIG. 486.

(B) **Subcutaneous Operation.**—For this operation small, narrow-bladed knives (tenotomes) are necessary. Usually a sharp-pointed straight tenotome suffices, but a probe-pointed instrument is occasionally useful. The shorter and narrower the blade, the better it is, so long as it is sufficiently strong (Fig. 486). The advantages of subcutaneous tenotomy are (*a*) diminished danger of infection; (*b*) absence of scar. The dangers of injury to neighboring important structures are slight, and in most localities easily avoided.

Tenotomy of Tendo Achillis (Achillo-tenotomy).—1. Cleanse the foot and leg, and turn them over on to the outer side. By palpation locate the most accessible part of the tendon. (The position of choice for section is ½ inch above the insertion in infants and 1½ inches in adults.)

2. Introduce a sharp-pointed tenotome through the skin under, *i. e.*, anterior to, the tendon. Keep the flat surface of the tenotome parallel to the tendon.

3. Turn the cutting-edge of the tenotome against the tendon.

4. Have the assistant flex the foot until the tendon is tense.

5. Press the tenotome against the tendon and by a slight levering motion divide it. Take care not to injure the skin.

6. Withdraw the knife after turning its blade once more parallel to the tendon. Apply dressings.

N. B.—Beginners frequently perforate the tendon with the tenotome and do not get complete division. Many surgeons in Step 2 pass the tenotome behind the tendon and cut forwards; others, having made a passage alongside the tendon with the sharp-pointed tenotome, substitute a probe-pointed one for the division of the tendon.

Tenotomy of Tibialis Anticus.—This tendon is usually divided near its insertion into the internal cuneiform. The surgeon stands on the opposite side of the leg to that of the tendon. The assistant grasps the leg and the foot in his hands. Abduction and plantar flexion demonstrate the position of the tendon.

Step 1.—Place tips of fingers on the opposite edge of tendon.

Step 2.—Introduce the tenotome through the skin a short distance from the proximal edge of the tendon.

Step 3.—Change the direction of the knife and pass it horizontally over the tendon until its point is felt by the finger guarding the opposite side.

Step 4.—Have the assistant make the tendon tense (abduction and plantar flexion of foot).

Step 5.—Turn the edge of tenotome against the tendon and divide it.

Step 6.—Withdraw tenotome. Dress in a position of eversion.

Tenotomy of Tibialis Posticus.—Point of division should be about 1½ inches above the internal malleolus. The surgeon stands in same position as in tenotomy of the tibialis anticus. Demonstrate the tendon by abduction and plantar flexion of the foot.

Jacobson writes: "In fat infants it is often quite impossible to feel the tendon, and in these cases a spot midway between the anterior and internal borders of the leg will be the best guide, as denoting the inner margin of the tibia. The surgeon then in-

troduces a sharp tenotome so as just to touch, if possible, the inner margin of the tibia, taking care to sink the blade sufficiently to open the sheath freely. This being done, a blunt tenotome is introduced through the same opening, and pushed under the tendon; the edge being then turned towards it, and the tibia used as a fulcrum, the tendon is severed, together with that of the flexor longus digitorum."

Division of Plantar Fascia.—The plantar fascia may be divided in several places: immediately in front of its origin from the os calcis; beside the transverse crease which is present in all marked cases of plantar contracture, or in any line which may seem suitable. Division in more than one place may be necessary before satisfactory results are obtained.

Step 1.—The assistant makes the fascia tense, and the surgeon, by palpation, satisfies himself as to its "geography."

Step 2.—A tenotome is introduced through the skin, at the inner side of the fascia (the fascia is not kept tense at this stage), and passed, with its flat surface parallel to the skin, between the skin and fascia across the sole until its point is beyond the outer edge of the fascia.

Step 3.—The cutting-edge of the tenotome is turned against the fascia, now made tense by the assistant, and this structure is divided.

Step 4.—The tenotome is withdrawn, suitable dressings applied, and the foot immobilized in a position of overcorrection.

CHAPTER VI.

OPERATIONS ON TENDONS AND TENDON SHEATHS.

Operation is most commonly performed on the sheaths of tendons for the removal of tuberculous disease.

Apply a tourniquet above the site of disease. Make an incision over the swelling, following the course of the tendon. Split the sheath of the tendon wide open. Retract the edges of the sheath wound with sharp hooks or volsella. Dissect away all diseased tissues. If possible, do not touch the wound with the fingers unless gloves are worn. Rub into the whole wound sterile iodoform. Close the wound by sutures. Apply dressings and splint.

Tendon Suture: Tenorrhaphy.—To avoid unnecessary cutting it is well to use a round needle, such as is used in intestinal work, but this is not of much importance. All the ordinary suture materials are used, viz., catgut, silk, hemp, silkworm-gut, silver wire, kangaroo tendon, etc. If catgut is chosen, it ought to be of the chromicized variety.

The accompanying figures elucidate the various methods of applying sutures better than any number of words (Figs. 487 to 496). Note in Fig. 491 the supporting suture, and in Fig. 494 the ligatures tied around the ends of the tendon to prevent the sutures tearing out. All the above methods of suturing are applicable where the divided ends of tendon can be brought into direct apposition. Sometimes it is necessary to suture a round to a flat tendon, in which case the flat may be folded over the round and there fixed by a few stitches (Fig. 497). Or the end of one tendon may be drawn through a split or "button-hole" in another tendon and sutured (Figs. 498, 499, 500).

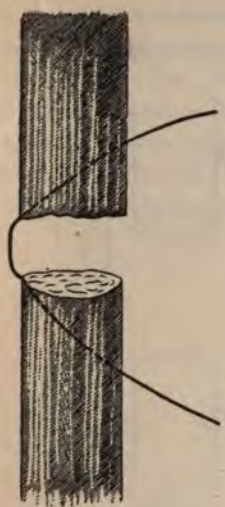

Fig. 487.

Fig. 488.

Fig. 489.

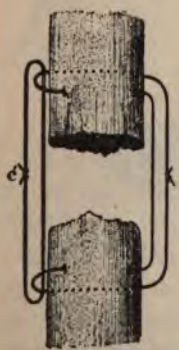

Fig. 490.

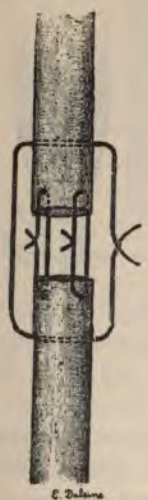

Fig. 491.

Fig. 492.

Fig. 493.

FIGS. 487 TO 493.—(*Monod and Vanverts.*)

Tendons being composed of parallel bundles of fibres, it is easy for sutures to cut their way out by separating the fibres.

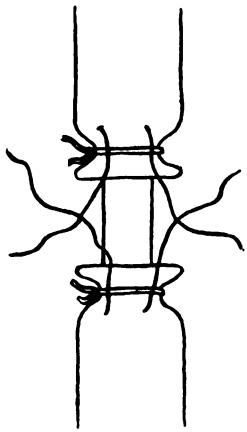

FIG. 494.

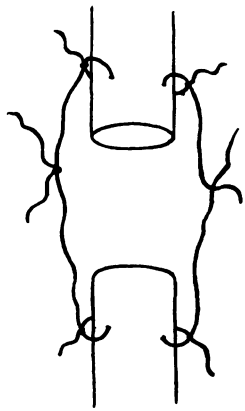

FIG. 495.

Suter ("Arch. f. klin. Chir.," lxxii, 728) describes several easy and efficient means of avoiding this accident. Figures 501, 502, 503,

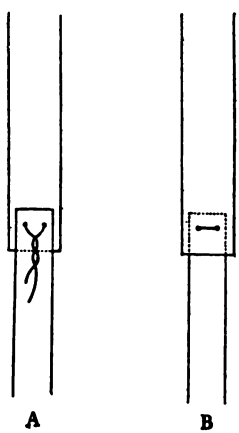

FIG. 496.

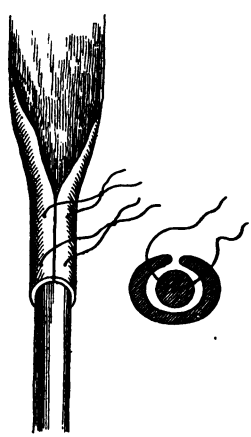

FIG. 497.

504, and 505 show how the sutures are introduced; the ends of the sutures are tied together at one side of the tendon (Fig. 506).

After the sutures are in place tie the two ends A A^1 to the two ends B B^1 (Fig. 507) and thus obtain lateral approximation of the ends of the tendon. For further security the two ends of suture A A^1 may be made to surround both segments of tendon, and the same may be done with the suture B B^1 (Fig. 508). After healing takes place it becomes impossible to distinguish between an union obtained by this method and that by end-to-end approximation.

Fig. 498.

Fig. 499.

Fig. 500.

FIGS. 498, 499, 500.—(*Vulpius.*)

If end-to-end approximation is desired, the sutures A A^1, B B^1, may be used as relaxation sutures, as in Fig. 509. Often it is impossible to bring the ends into the desired apposition, owing to shrinkage, loss of substance, or the exigencies of transplantation, and various means of tendon-lengthening must be used. Figs. 510, 511, 512, and 513 show the best-known methods. Occasionally the above means are inapplicable, and in order to obtain union between the separated ends of tendon it is necessary

to fill the gap with some suture material or a graft. Figs. 490 and 491 show how such sutures may be applied. A number of strands

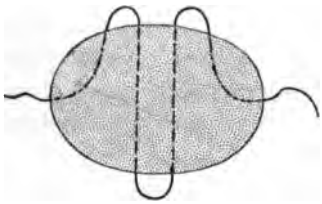

FIG. 501.

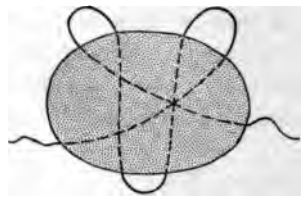

FIG. 502.

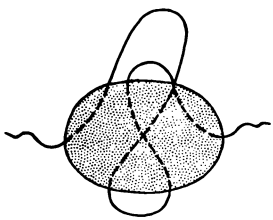

FIG. 503.

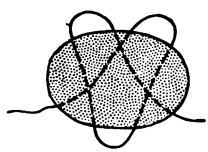

FIG. 504.

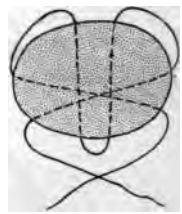

FIG. 505.

of catgut or catgut and silk together may be formed into a small cable the ends of which may be sutured to the divided ends of the tendon. Whatever material is used to fill the gap, it merely

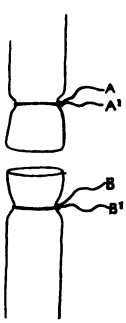

FIG. 506.

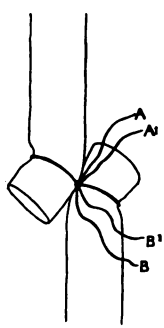

FIG. 507.

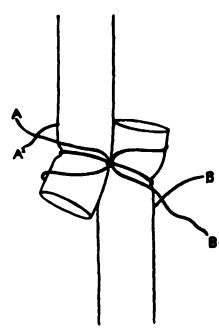

FIG. 508.

acts as a guide or scaffold along which nature may deposit new tendon tissue or a substitute therefor. Vulpius finds that even

after aseptic healing silk sutures are ultimately thrown off, without ill result, in 15 to 20 per cent. of all cases when used as ordinary tendon sutures. When used as grafts, more damage must follow. Probably as a graft, chromicized catgut or prepared tendon is preferable to silk. A combination of silk and catgut is well recommended. If two neighboring tendons are in part destroyed by the same accident, a portion of the less important one may be used to replace the defect in the more important (Fig. 514). When, as a result of an incised wound,

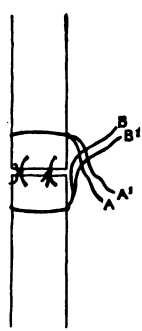

FIG. 509.

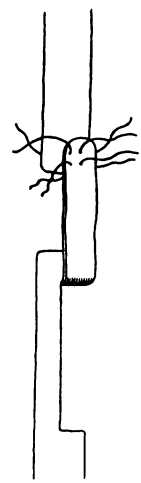

FIG. 510.

e. g., of the dorsum of the foot, a tendon is divided, the proximal end is immediately retracted into its sheath. To find the retracted portion pass forceps up the sheath, seize the tendon, and pull it down. Very commonly this procedure is futile, and we are compelled to split open the sheath for a greater or less distance upwards. The retracted tendon may be forced downwards by methodically pressing the muscular belly downwards or by applying an elastic bandage tightly around the limb from the origin of the muscle at fault downwards. If after thorough and extensive search the upper end of the tendon cannot be found, the distal

end ought to be united to a neighboring tendon by the methods shown in Figs. 498, 499, and 500. The approximated surfaces of tendon must, of course, be suitably freshened before the sutures are applied.

Sometimes the proximal end of the tendon is accessible and the distal lost or destroyed. Several methods of treatment are applicable: (*a*) The end of the tendon may be united to the side of a neighboring tendon. (See "Transplantation of Tendons.") (*b*) The end of the tendon may be fixed to the periosteum

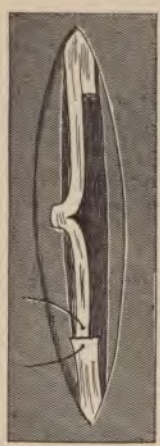

Fig. 511.

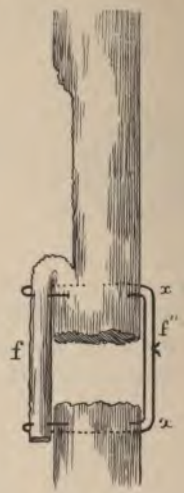

Fig. 512.

Fig. 513.

FIGS. 511, 512, 513.—(*Monod and Vanverts.*)

or to the bone itself at a point as near as possible to its normal insertion. (*c*) The end of the tendon may be united to the bone at its normal point of insertion by the intermediation of a catgut or silk graft.

Implantation of tendon to periosteum or bone may be effected as follows:

Method 1 (Lange).—With knife and periosteal elevator raise a flap of periosteum, $\frac{1}{2}$ to $\frac{3}{4}$ inch in length, at the site chosen for the tendon insertion. Suture the end of the tendon to the

periosteal flap. When the tendon is not long enough to reach the point of insertion, Lange makes use of a double suture of strong silk as a graft.

Method 2 (Wolff).—Divide the periosteum at the site selected. Reflect the periosteum laterally. With a chisel, cut a gutter or groove in the exposed bone. Place the tendon in the bone gutter. Replace the periosteal flaps *over* the implanted tendon and suture them together and to the tendon (Fig. 515).

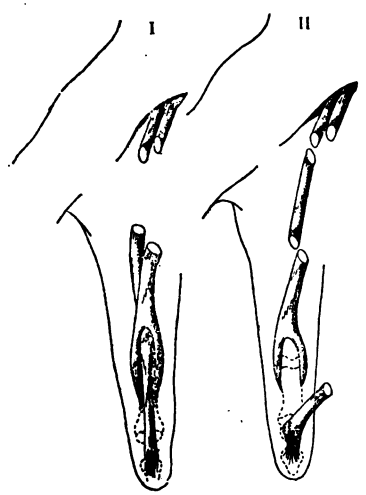

FIG. 514.—(*Monod and Vanverts.*)

When tendon suturing is done as a secondary operation, the ends of the tendon will be found adherent to a mass of scar tissue lying between them, and which is firmly adherent to surrounding structures, especially to the skin. Before the vivified ends of the tendon are united this mass of firm, hard tissue must be thoroughly excised and adhesions which prevent approximation and gliding of the tendons must be broken down.

Where it seemed impossible to obtain a satisfactory result by excising the scar tissue in a case in which the distal portion of the flexor of the index finger was adherent to the cicatrix, Chas-

saignac sought for, found, and united the proximal portion of the tendon to the scar close to the distal portion (tendo-cutaneous suture).

After-treatment.—The wound having been closed, if possible without drainage, abundant dressings are applied, and the parts fixed by splints or plaster-of-Paris in such a position that tension on the sutures is relaxed. No attempt at motion should be made before the lapse of two weeks, in the case of the smaller tendons; for the larger tendons or in cases where grafts (of catgut, silk, etc.) have been employed, a longer period of rest is proper. After this passive and then active motion must be begun, aided

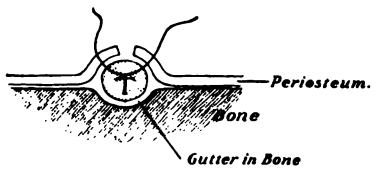

FIG. 515.

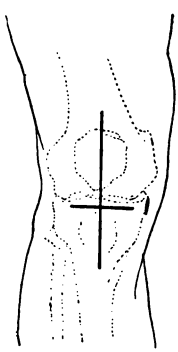
Fig. 516.

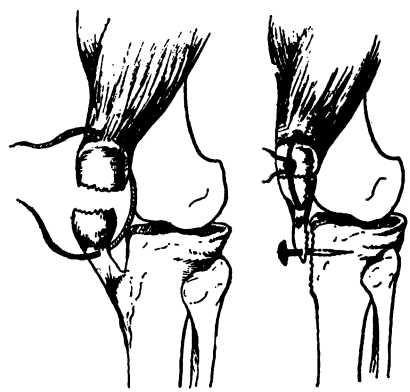
Fig. 517.

FIGS. 516 AND 517.—(*Monod and Vanverts.*)

by massage and electrical stimulation. Owing to the occurrence of atrophy from disuse the after-treatment will be more prolonged where the tenorrhaphy was secondary than where it was performed at the time of the original injury.

Approximation of Severed Ends of Tendon by Means of Transplanting Its Osseous Insertion (Bergmann, Poncet).—It may be impossible, by ordinary means, to approximate the fragments in transverse fracture of the patella or in rupture of the ligamentum patellæ or quadriceps tendon, but the following operation may suffice to permit it:

Step 1.—Expose the parts by means of a vertical or crucial incision (Figs. 516, 517).

Step 2.—With a chisel separate the tibial tubercle, and with it the ligamentum patellæ from the tibia.

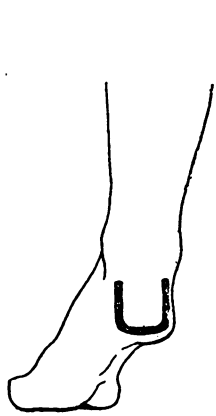

Fig. 518.

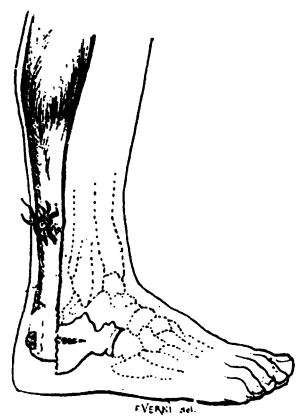

Fig. 519.

FIGS. 518 AND 519.—(*Monod and Vanverts.*)

Step 3.—Divide any adhesions which prevent approximation.

Step 4.—Unite the fragments of bone or tendon by strong sutures.

Step 5.—The fragments of bone or tendon having been united, the separated tibial tuberosity attached to the ligamentum patellæ has slipped upwards and assumed a new position on the surface of the tibia. Fix the tibial tuberosity in its new position by means of a buried ivory peg or by a steel nail which is left protruding through the skin-wound, to be removed after union has been secured.

Step 6.- Suture the fascia and skin-wounds. Apply dressings. Immobilize with splints or plaster-of-Paris in extended position and elevate the limb.

A similar operation may be used in cases where there is much

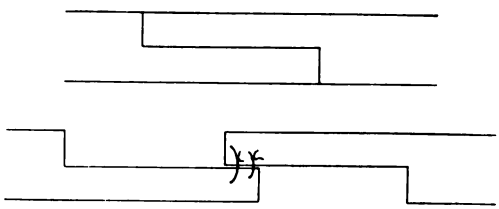

FIG. 520.

loss of substance in the tendo Achillis or in the tendon of the triceps brachialis. Figs. 518 and 519 are self-explanatory.

For the correction of deformity, tendons which have never been divided often require to be lengthened. Tenotomy is the most common means of securing the necessary elongation. (See

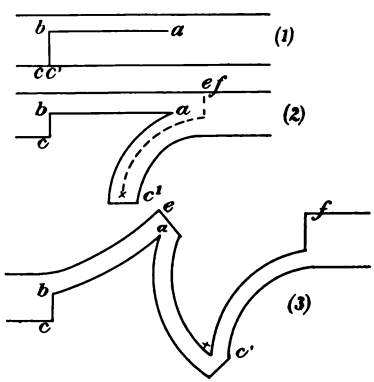

FIG. 521.

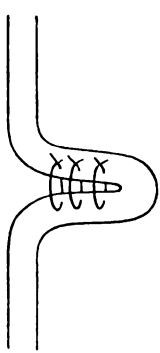

FIG. 522.

"Tenotomy.") Poncet's method of making shallow lateral incisions (Fig. 513) may be of service under such circumstances. Anderson's method of tendon lengthening by splitting, sliding, and suturing is shown in Fig. 520. The Hibbs-Sporon method can be readily grasped by glancing at Fig. 521.

Tendon Shortening.—After the correction of deformity certain tendons may be too long for the proper transmission of power, or the exigencies of transplantation may require that they be shortened. Figs. 522 and 523 show a simple reduplication of the tendon. In Fig. 524 the tendon is split longitudinally and the longitudinal converted into a transverse wound. In Fig. 525

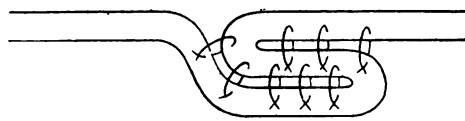

FIG. 523.

the whole thickness of the tendon has been cut away with the exception of a thin slip at the side, which aids in the subsequent healing. In Fig. 526 a "draw" stitch when pulled tight throws the tendon into folds and so shortens it. Other methods of tendon shortening will be incidentally described in the paragraphs devoted to transplantation.

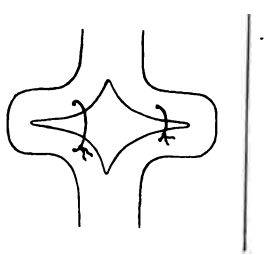

FIG. 524.

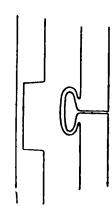

FIG. 525.

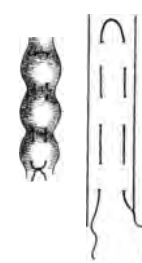

FIG. 526.

Displacement of Peroneus Longus Tendon.—Make an incision about two inches in length, obliquely from above downwards and forwards, over the outer surface of the external malleolus (Fig. 527). Do not cut deeper than the subcutaneous tissue. Expose the external annular ligament, which is torn when the peroneus tendon is luxated. If the fragments of the ligament can be brought into apposition over the tendon, suture them in their normal position. If this cannot be done, expose a larger surface

of the external malleolus and from it raise a flap of periosteum with its base downwards. Turn this flap downwards and suture its free extremity either to the remnants of the annular ligament or to the periosteum of the os calcis. Another method consists in making the periosteal flap at a slightly higher level—turning it back over the peroneal tendons and there suturing it to the deep fascia (Fig. 528) (Walsham). Close the skin-wound without drainage. Dress. Immobilize for two weeks and then begin passive motion.

Tendon Transplantation.*—When there is a loss of muscular function, incapable of spontaneous recovery or of relief by simpler means, tendon transplantation may be of use. Loss of muscular function may be due to paralysis or paresis of a single muscle or of a group of muscles, or to an excess of power in one muscle or

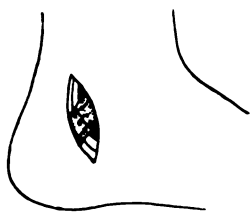

FIG. 527.

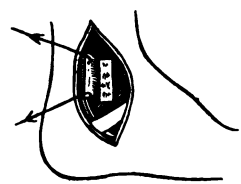

FIG. 528.

group of muscles, *i. e.*, there is a loss of balance between the muscles acting on a joint. Balance may be restored by transplanting power from the strong to the weak. In order that transplantation may be of use it is essential that the loss of function is limited in extent and that sufficiently powerful muscles are within convenient distance of the weakened ones, *e. g.*, no benefit could accrue from tendon transplantation in the case of a so-called "flail joint"; the loss of function is too widespread and there are probably no neighboring muscles in proper position to lend power.

Where there has been loss of tendon from accident or disease, and union, whether direct, by implantation, or by tendon length-

* In the preparation of the following pages very extensive use has been made of Dr. Oscar Vulpius' work, "Die Sehnenüberpflanzung."

ening, is impossible, then transplantation may restore function. Frequently paralysis following acute poliomyelitis is circumscribed, so that healthy muscles are found alongside paralyzed ones; in such cases transplantation may be valuable. Before operating, however, we must be very sure that spontaneous recovery is impossible. Never operate until six or nine months have elapsed since the paralysis appeared. Transplantation is of use not only in restoring function, but in obviating deformity.

The most common forms of partial paralysis requiring operation are those about the ankle evidenced by the presence of talipes calcaneus, paralytic varus and equino-varus, flat-foot. In spastic paralysis the want of muscular balance may be due to increased power in one set of muscles, with or without diminished power in the opposing muscles. Inflammatory arthritis may cause contractures remediable by transplantation.

A well-defined plan of procedure must be worked out in each case before operation is begun. We must know exactly which muscles are paralyzed completely or partially, and what power is available to aid them. In the case of adults we study the possible voluntary movements. Movements in weakened parts may often be demonstrated only when the corresponding muscles in the opposite limb are set in motion. Children we watch at play and stimulate certain muscles to act by tickling, etc. When contractures are present, they may hinder certain motions and may have caused atrophy in certain muscles from disuse. Electrical tests, according to Vulpius, are of comparatively little value. Weak currents do not stimulate sufficiently; stronger ones excite neighboring or even antagonistic muscles. The application of the electricity frightens children and does not help in distinguishing between paralysis and the atrophy from disuse.

When deformity exists, it ought to be corrected before the required tendon transplantation is attempted, *e. g.*, in paralytic club-foot with paralysis of the extensor digitorum; if we transplant part of the tibialis anticus tendon on to the tendon of the paralyzed muscle and *then* correct the deformity, the tendon is made loose and cannot transmit power to the foot. If, however, we

first correct the deformity and *then* make the transplantation, the tendon will have the proper tension for the transmission of power. If the operation for the correction of deformity is severe, transplantation should not be attempted until the parts have completely recovered from the operative trauma. If contracted tendons hinder complete correction of deformity, Vulpius defers the necessary tenotomy until he is ready to transplant, when he combines tenotomy and tendon splitting.

General Remarks on Method of Operating.—Incisions to expose the tendons should be longitudinal and so placed that they may be slid over all the parts it is necessary to expose. An incision ought *not* to be made directly over a tendon; it should be to one side of it. Flaps and V-shaped incisions lead to extensive skin dissection and favor the formation of adhesions.

If the donating tendon is remote from the receiving tendon, a second incision will be necessary, and the tendon is carried from the one opening to the other through a tunnel bored with a forceps. Numerous incisions may be made into both the donating and the receiving muscle. These incisions let us know the actual condition of the muscles. Next to a dark-red healthy muscle we may find a yellowish white muscle completely paralyzed and scarcely distinguishable from the surrounding fat. Another muscle may show varying shades of rose color (atrophy from disuse); such a muscle may recover. In still another muscle we may find all three conditions—health, paralysis, atrophy—in streaks.

In exposing the donating tendon a very long incision may be required, especially if it seems necessary to form two muscles out of one. Under such circumstances not only is a slip split off the donating tendon, but the tendon split or incision is carried well up into the muscle belly. In continuing the "split" up into the muscle do so by blunt dissection, and see that the portion of muscle left attached to each segment of tendon normally belongs to that segment. This renders possible the formation of two physiologically distinct muscles out of one (Figs. 529 and 530). The donating tendon must be conducted by as straight a route as

possible to the receiving one. To succeed in this, *e. g.*, when a flexor of the leg is to donate power to an extensor or vice versâ, it may be necessary and proper to conduct it through a tunnel bored in the interosseous membrane. When exposing tendons

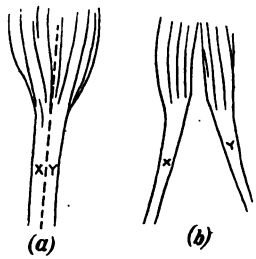

FIG. 529.

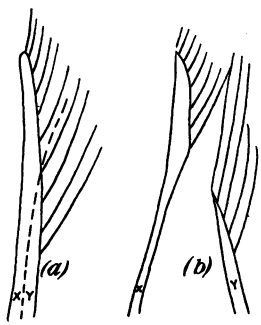

FIG. 530.

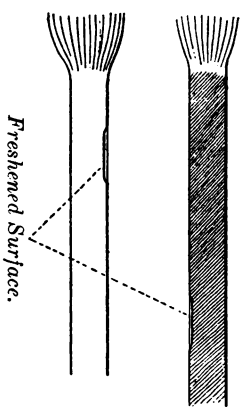

Fig. 531.

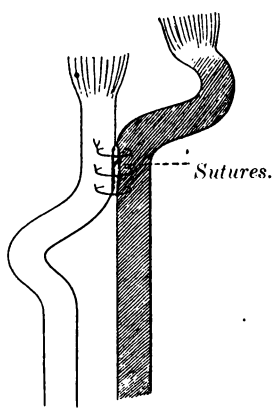

Fig. 532.

FIGS. 531 AND 532.—(*Vulpius.*)

through a long cutaneous incision it is not necessary to divide the fascia throughout the whole length of the wound; the fascial cut may be interrupted in places and thus union may be rendered easier and more exact. The fascia should never be divided near its insertion into bone, otherwise union will be difficult.

Methods of Uniting Transplanted Tendons.—Most of what has been written as to the union of divided tendons is applicable here. Figs. 531 to 543 illustrate sufficiently the usual methods of

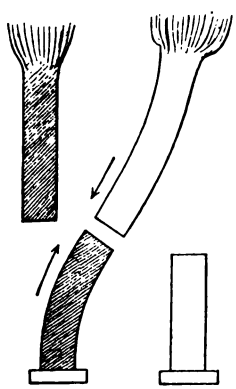

Fig. 533.

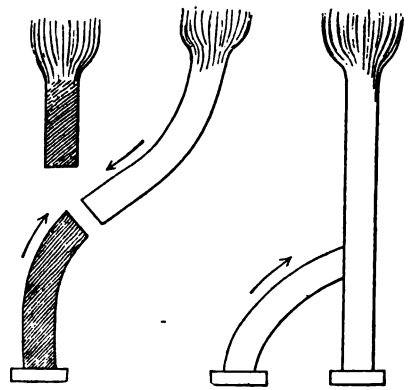

Fig. 534.

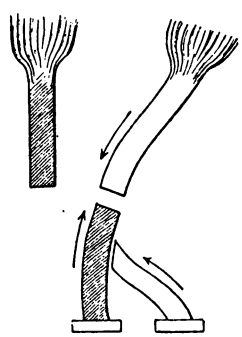

Fig. 535.

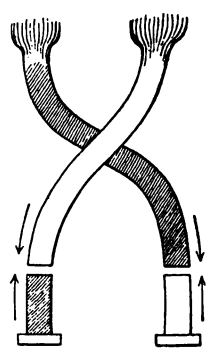

Fig. 536.

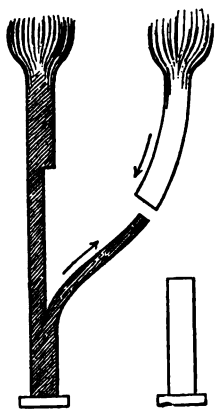

Fig. 537.

FIGS. 533 TO 537.—(*Vulpius.*)

transplantation. In the figures the non-paralyzed muscle and tendon (the donor) are uniformly left unshaded; the paralyzed muscle and tendon (the receiver) are shaded. Before applying sutures always vivify the surfaces to be united and always pull up any

"slack" there may be in the receiving tendon so that sufficient tendon tenseness is secured to permit of transference or application of muscle power to the point of tendon insertion. A lax tendon between muscle and point of insertion is useless.

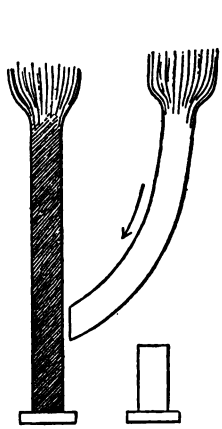

Fig. 538.

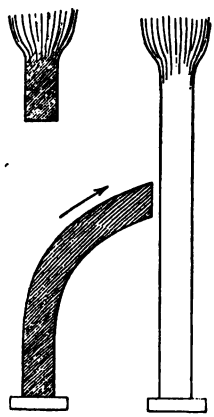

Fig. 539.

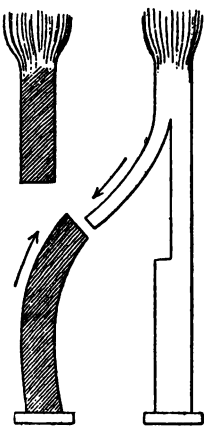

Fig. 540.

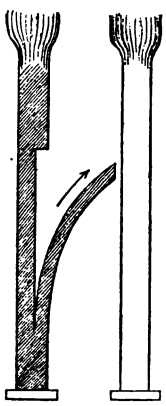

Fig. 541.

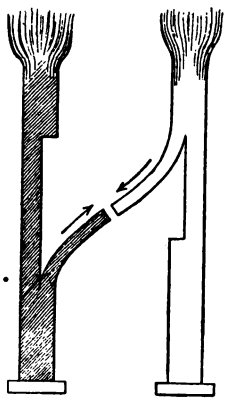

Fig. 542.

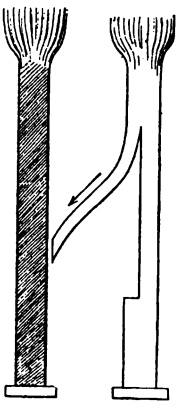

Fig. 543.

FIGS. 538 TO 543.—(*Vulpius.*)

In Fig. 533 the tendons both of the donor and of the receiver are completely divided and the peripheral portion of the donor is dis-

carded, *i. e.*, none of the normal function of the donor is retained: This procedure is justifiable only when the donor is an entirely unimportant muscle or if, under the circumstances for which operation is undertaken, its normal action is objectionable. Functionally negligible muscles are rare, and unexpected evils are liable to follow when even unimportant muscles are entirely cut off from their normal insertion. To obviate part of this, many devices have been suggested, and most of them will be easily understood after a glance at the figures.

Indirect tendon transplantation may be necessary when the donor is not long enough and where the ordinary methods of implantation seem inadvisable. Mainzer (quoted by Vulpius)

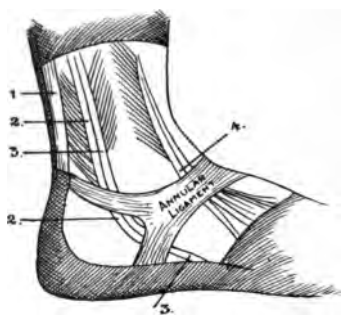

FIG. 544.

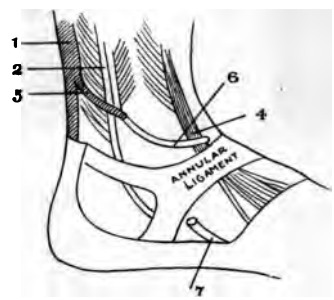

FIG. 545.

1. Tendo Achillis. 2. Peroneus longus. 3. Peroneus brevis. 4. Extensor tendons. 5. Slip from tendo Achillis. 6. Tendon of peroneus brevis used as a graft.

used the following plan in a case of paralysis of the extensors of the toe: Form a slip from the tendo Achillis (Figs. 544 and 545); suture the end of this slip to an appropriate point on the peroneus brevis tendon. Divide the tendon of the peroneus brevis at such a place that a sufficiency of the tendon is left below the point of suture with the tendo Achillis to reach from that point to the extensors which require strengthening. Pull this chosen portion of tendon centralwards out of its sheath and sew its end to the extensors (Fig. 545, 6).

Closure of Wound.—Suture the wounded tendon sheaths

with very fine catgut. Carefully suture the deep fascia with buried sutures. Close the skin-wound. Apply abundant dressings and apply a stiff bandage.

After-treatment.—Keep immobilized for six weeks in simple cases, for eight weeks in cases where there has been much deformity, especially bony deformity, corrected. The period of rest is shortened if there is cause to fear adhesions, *e. g.*, if the tendon has been left outside the fascia or traverses an interosseous space. For a period of four weeks the patient ought to remain *in bed* to avoid any chance of injury to the lines of suture. After union is complete applications of moist and dry heat stimulate the circulation. Electrical stimulation is advantageous. Passive motion and, as soon as possible, gymnastic exercises are necessary. When the patient begins walking some simple form of supporting apparatus or boot will be necessary for a longer or shorter time.

CHAPTER VII.

VEINS.

VARICOSE VEINS.

An attempt radically to cure varicose veins in the leg is proper when palliative treatment by means of elastic pressure is inefficient, impossible, or markedly inconvenient to the patient, and when at the same time the varicosities are causing annoying symptoms or danger is feared.

Trendelenburg's Operation.—This operation is based on the fact that, when the long saphenous vein is dilated, blood flows back into it from the femoral.

The Operation.—Local anæsthesia usually suffices. Place a rubber band around the upper part of the thigh sufficiently tightly to cause dilatation of the superficial veins. This precaution may be dispensed with if desired. At the junction of the upper and middle thirds of the thigh make a longitudinal incision about one and one-half inches in length along the course of the vein. A transverse incision is preferable in fat patients. Expose and isolate the vein; ligate it with catgut at the upper and lower ends of the wound; excise the portion lying between the ligatures. Close the wound with sutures. Dress. Repeat the above procedure at a point immediately below and one immediately above the internal condyle. Keep the limb at rest for from two to three weeks. When painful varicose tumors are present, the author always supplements the Trendelenburg operation by excising such.

The Mayos excise the long saphenous vein as follows: Expose and isolate the vein near the saphenous opening. Divide the vein between ligatures. Seize the peripheral portion of the vein with a hemostat. Using a long narrow dressing forceps as a blunt dissector, burrow under the skin and separate the venous

trunk from its surroundings (Fig. 546). When sufficient vein has been isolated, guided by the point of the forceps incise the skin, ligate the vein, and remove its mobilized portion.

O'Conor operates as follows: Shave and disinfect the limb from Poupart's ligament to the ankle. Doubly ligate and divide the internal saphenous vein through a two-inch incision made over the saphenous opening. If no varicosity exists above the knee, close and dress the wound. If the femoral portion of the vein is affected, continue the incision downwards and dissect out the whole of the diseased vein. In some cases an eighteen- or twenty-inch incision is necessary. If the disease does not extend above the knee, after occluding the saphenous trunk as described above, make an incision over the affected portion, apply a ligature above and below, and remove the whole mass by dissection. Of course, all branches are caught up with pressure forceps, and when the main channel is removed, they are ligated. As, frequently, the external saphenous vein is also affected, its varicose portion is dealt with in a similar fashion.

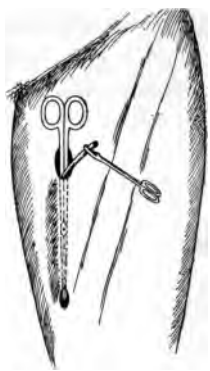

FIG. 546.

Phelps' Operation.—Pass a handled needle with its eye near the point through the skin, behind the vein, and out through the skin on the opposite side of the vein. Thread the needle with stout silk; withdraw the needle and unthread it. Through the same puncture reintroduce the needle; pass it in *front* of the vein and out through the skin puncture on the opposite side of the vein made in the previous movement. Thread the free end of the silk ligature in the needle and withdraw the needle. By the above means a silk ligature has been made to surround the vein, and its two ends emerge through the same puncture in the skin. Tie the ligature tightly. Repeat the operation at about thirty or forty places. Apply dressings and prescribe rest in bed.

WOUNDS IN VEINS.

When a small vein is wounded, the best treatment is, of course, to stop the bleeding by the pressure of a compress or forceps or by the application of a ligature. When a larger vein is completely divided, the same treatment is proper. Occasionally a vein is wounded in such a location that it is impossible to apply a ligature; in this case the bleeding may be staunched by packing the wound with gauze, or a forceps may be applied and left in place for from twenty-four to forty-eight hours or longer. During operation in various localities, notably the neck and axilla, a large vein may easily be wounded by accident or design. The wound may be picked up in the jaws of an artery forceps and a ligature applied laterally, so that the wound is closed, while circulation continues in the vein, whose calibre is of course considerably diminished.

Schede has improved on the above treatment by closing the wound with sutures. He uses thin catgut introduced by fine Hagedorn or better rounded or intestinal needles. The swelling of the catgut after it has been introduced closes the needle punctures and prevents escape of blood through them.

The method of suture employed is the ordinary continuous stitch, including in its bite all the coats of the vein. Bleeding is prevented during suturing by finger or sponge pressure applied above and below the wound, or by forceps attached close to the wound itself. In the hands of Schede venous suture has never failed in giving satisfaction.

In removing a cancerous kidney Schede threw an elastic ligature around the pedicle and included a portion of the vena cava in the ligature. On examination of the pedicle it was found that the walls of all the vessels were diseased and individual ligation was impossible. It was impossible to leave the elastic constrictor *in situ*. "Under careful compression of the vena cava, above and below, by means of sponge-sticks, the ligature was removed. Violent hemorrhage took place from the opposite renal vein. The wound in the vena cava was quickly closed by

two artery forceps so placed that their blades surrounded the wound by converging from above and below, their points meeting near the middle of the vena cava. Bleeding ceased and the remnants of the tumor could be removed. A hole about ¾ inch in length was found in the vena cava. This was sutured. The forceps were removed. There was no bleeding." The patient lived for thirteen days. Postmortem, narrowing of the vena cava was found at the site of operation, the wound was solidly healed, the intima was smooth, and there was not the slightest trace of thrombosis.

PART VI.—THE SPINE.

OPERATIONS ON THE SPINE.

It is important to recognize certain easily remembered relations which exist between the spinal cord and the spinous processes. These relations are thus described by Chipault:

(*a*) The terminal cul-de-sac of the dura mater corresponds to the fifth lumbar interspinous space.

(*b*) The inferior limit of the spinal cord is situated in men at the level of the first, in women, of the second, in infants, of the third, lumbar spinous process.

(*c*) The cervical segment of the cord terminates at the level of the sixth cervical interspinous space; the dorsal, at the ninth dorsal; the lumbar, at the inferior border of the twelfth dorsal spine; the sacral segment ends at the superior border of the first lumbar spine.

(*d*) The relations of the summits of the spinous processes to the nerve roots may be expressed by a simple formula which, while not mathematically correct, is sufficiently so to act as a guide in surgical intervention.

For adults the formula is: In the cervical region to find the nerve which emerges at the level of any individual spinous process, add the numeral one to the number of the process, *e. g.*, it is the third cervical root which emerges opposite the second spinous process. In the superior dorsal region add the numeral two to the number of the process. From the sixth to the eleventh dorsal processes add the numeral three. The inferior part of the eleventh dorsal spinous process and the subjacent interspace correspond to the origin of the sacral nerves.

For children under the age of six or seven years following the

modification of the formula holds good: In the superior dorsal region (from the first to the fourth apophysis) add three to the number of the spinous process to obtain the number of the corresponding nerve root; in the mid-dorsal region (fifth to ninth apophyses) add the numeral four.

LAMINECTOMY.

Laminectomy is the operative means by which the spinal canal is opened for exploratory or therapeutic purposes.

Method A.—*Step* 1.—Make a vertical median incision over the spinous processes. This cut reaches directly to the spinous processes, and is at least four inches in length.

Step 2.—On one side of the spine separate by sharp and blunt dissection the muscles from the side of the spinous processes and from the back of the laminæ of the vertebræ. Bleeding is usually severe. Quickly pick up the bleeding vessels with forceps and pack the wound with gauze wrung out of very hot water. Separate the muscles on the opposite side in the same way.

Step 3.—Choose the point at which to enter the spinal canal. Divide the interspinous ligament. Cut away the spinous process with rongeur forceps, and with the same instrument cut away part of a lamina. With Keen's rongeur forceps remove as much of the laminæ of several vertebræ as may be required to give free access to the spinal canal.

Step 4.—Inspect carefully the contents of the spinal canal. Examine the anterior as well as the posterior surface of the cord. The cord may be gently pulled to one side without damage resulting. Note the condition of the posterior surface of the vertebral bodies.

Carry out any therapeutic measures which may be indicated. If it seems necessary to open the dura mater, do so, and close the opening with fine catgut sutures. Having completed the exploration or whatever operative measures may have been necessary, close the external wound by deep and superficial sutures,

with or without drainage. Generally drainage during the first twenty-four hours is advisable. Apply the usual dressings and carry out subsequent treatment on the ordinary principles of surgery.

Method B.—Make a U-shaped incision around the area of spine to be attacked. Through the vertical limbs of the U expose and divide the vertebral laminæ with chisel, saw, or forceps. Divide the interspinous ligament opposite the transverse part of the U cut. Expose the spinal canal by reflecting the U-shaped flap which contains, besides the skin and soft structures of the back, the spinous processes and part of the vertebral laminæ. The rest of the operation is the same as in Method A.

TUMOR OF THE SPINAL MENINGES.

Expose the spinal canal by Method A. If the tumor is external to the meninges extirpate it, being careful to avoid injury to the nerve roots. If any nerve leaving the cord is divided, it should, if possible, be immediately reunited by suture. The posterior surface of the meninges is generally separated from the bone by a collection of fat containing many veins; thus hemorrhage may be troublesome, but this can be readily stopped by packing with strips of gauze wrung out of very hot water. When the tumor is inside the dura, that membrane must be divided, the limits of the growth defined, and its removal effected by careful blunt dissection. After attending to hemostasis the wounded dura may be sutured or not, according to indications.

Tumors of the cord itself are not amenable to surgical treatment.

FRACTURE OF THE SPINE.

Except when functional disturbance is very slight or when shock is very severe, Chipault gives the excellent advice to operate. Reduction by extension and local pressure is condemned, as such manœuvres are very liable to press fragments of bone into the cord and increase the damage immensely.

The time to operate is *early*, before there is time for secondary degenerations to become established. Not many days should elapse between the injury and the operation.

Open the spinal canal by Method A. Remove all blood-clot and severely damaged tissues. Stop bleeding. Examine thoroughly the posterior surface of the cord. Examine the anterior wall of the spinal canal. If there are displacements of bone in this location, interfering with the cord or lessening the calibre of the spinal canal, try to reduce such by manipulations under the guidance of the eye and finger. If manipulations fail, cut away such pieces of bone as threaten the integrity of the cord or jut into the canal. This may be done with the chisel or rongeur forceps. The amount of bone removed may be considerable. Examine the cord once more. If it does not pulsate and presents a distended and bluish appearance, open the dura and clear out the blood-clot which will be found. If the cord is flabby and small, there are probably adhesions existing between the membranes and the cord or between the various nerve roots. This condition calls for the dura to be opened and the adhesions separated.

Any operation undertaken must be done thoroughly. The wound in the dura should be closed, unless this is contra-indicated. The external wound is sutured as usual, dressings applied, and the trunk immobilized. Harte and Stewart ("Trans. Am. Surg. Assoc.," xx) report the case of a woman twenty-six years of age who was shot at the level of the seventh dorsal vertebra. Operation showed that the spinal cord was completely severed, a gap of $\frac{3}{4}$ inch existing between the segments. After removal of lacerated and fragmented tissues the cord was united by three chromicized catgut sutures. Sixteen months after operation "the patient voluntarily flexes the toes, flexes and extends the thighs, and rotates the hips. While sitting the extended leg can be raised from the floor; . . . . the patient can slide out of bed into her chair by her own efforts. . . . The bowels move every second day and are under perfect control, excepting the presence of diarrhea."

SPINA BIFIDA.

To understand the operative treatment of spina bifida and the limitations thereof it is absolutely necessary to have clear notions as to its pathological anatomy. The usual surgical text-books rarely provide such notions, hence the author will try to describe, very briefly, the conditions as they exist which should influence operation.

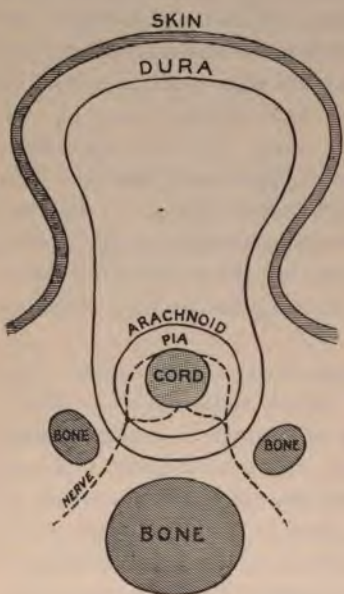

FIG. 547.

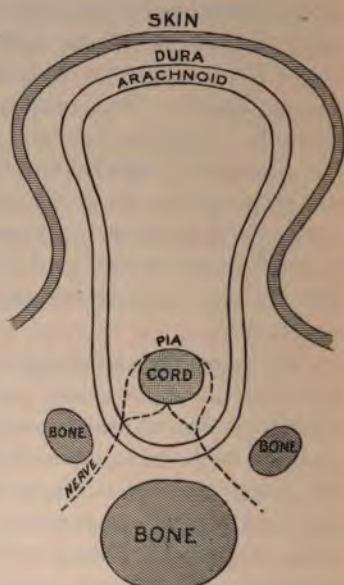

FIG. 548.

(A) **Meningocele.**—A defect of the posterior osseous wall of the spinal canal is present. The skin, spinal membranes, and cord are intact. There is a hernia of the dura through the osseous defect. Fluid in greater or less quantity is present in the dilated subdural space (Fig. 547).

(B) **Meningocele.**—The conditions are the same as in A, except that the arachnoid is involved in the hernia and the collection of fluid is in the subarachnoid space (Fig. 548).

(C) **Meningocele.**—A defect exists in the dura as well as in the bone. Through these defects there protrudes a hernia consisting of the arachnoid with fluid accumulated in the subarachnoid space. The skin, pia, and cord are intact.

(D) **Myelo-cystocele** (Fig. 549).—There exists a defect in the posterior osseous wall of the spinal canal and also in the corresponding portion of the dura. The arachnoid and pia are intact. The central canal of the spinal cord is highly distended by fluid, so that a hernia is formed having the arachnoid and pia as sac. The cord substance is thinly spread out over the inside of the sac—so thinly that in places it is absent. The spreading out of the cord is due to the distention. As will be seen by reference to the diagram, nerve roots run forwards *in* the hernial sac. This is of importance to the operator.

(E) **Myelocele.**—A defect exists in the skin, in the posterior osseous wall of the spinal canal, and in the corresponding portions of the dura, arachnoid, and pia. The posterior surface of the cord itself is split or absent. The central canal of the cord is open to the air (Fig. 550). Fluid collects between the pia and arachnoid anterior to the cord, and gives rise to a spinal hernia. As will be seen by referring to the diagram, skin is present only at the base of the tumor; the hernial sac consists of pia mater with a covering of cord substance. The nerve roots run from the cord forwards through the sac. Should a collection of fluid form in the arachnoid instead of in front of it, then the arachnoid will form part of the hernial sac and the nerve roots will run forwards in the sac wall.

(F) **Myelocele.**—This form is the same as E except that there is no collection of fluid (Fig. 551). The remnant of cord substance lies in a groove or depression on the back and is continuous with the skin. The meninges are continuous with the subcutaneous tissues.

The differential diagnosis of myeloceles (E and F) is easy. They are inoperable.

The diagnosis between myelo-cystocele (D) and meningoceles (A, B, and C) is generally impossible, except perhaps, as Horsley

has suggested, by applying the electric current and observing its effects. Myelo-cystoceles are more frequently accompanied by other deformities, *e. g.*, club-foot, exstrophy of the bladder, etc., than are meningoceles. The fact that the walls of a myelo-cystocele contain nerve substance while those of meningoceles do not makes positive differentiation between the two forms of spina bifida indispensable for scientific treatment. If we inject

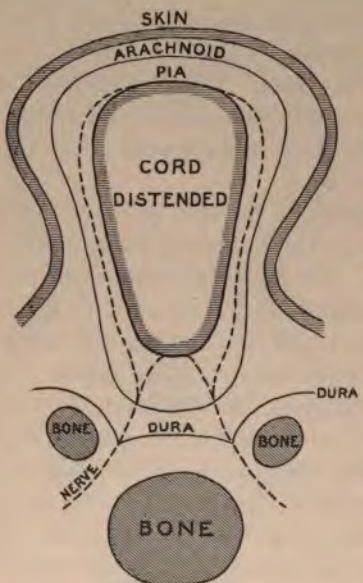

FIG. 549.

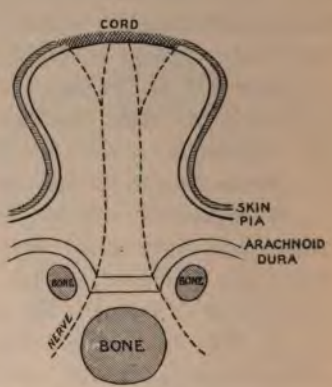

FIG. 550.

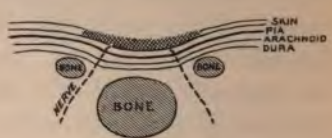

FIG. 551.

a solution of iodine (Morton's fluid) into the sac, we may be really throwing it into the central canal of the spinal cord. The injection of iodine has been, until recently, the favorite treatment for spina bifida, but in view of the facts related above one is compelled to believe it unscientific.

Operation is contraindicated in cases of myelocele; in cases of spina bifida accompanied by paralyses or contractures evidencing irreparable defects in the cord substance; in cases of severe

hydrocephalus or of abdominal or vesical fistulæ—in all other cases operation is proper.

The Operation.—Step 1.—Make two skin-flaps from the base of the tumor, of sufficient size to cover the wound left after removal of the sac. These flaps should be made large rather than small, as it is easy to trim them to suit before applying sutures.

Step 2.—Having exposed the sac by reflecting the skin-flaps, make an incision into it on one side. This incision should be made transversely and must not reach to the middle line of the body (*i. e.*, to the apex of the tumor). The reason for these precautions is that most of the medullary tissue, if present, is situated in the middle line, and that the general course of any nerve roots is from the summit of the sac to the base, *i. e.*, parallel to the direction of the incision.

Step 3.—Explore the sac and observe whether nerves lie free in it (Fig. 4) or are enclosed in its walls (Fig. 3). If the nerves lie free in the sac, trace them to their point of origin in the medullary substance which forms part of the sac. Separate the medullary substance, and such of the sac as is united to it, from the rest of the sac and reduce it into the spinal canal. Remove the excess of sac. If the nerves lie in the sac wall, empty the sac of its fluid and reduce it *en masse* after removing all skin from over it. If the case be discovered to be one of meningocele, remove the whole sac after suturing its base.

Step 4.—Close the wound by a series of deep and superficial sutures.

Some surgeons have recommended that the osseous defect be closed by means of a flap of bone obtained from the crest of the ilium and provided with a pedicle. This procedure must rarely be indicated.*

*For a thorough description of spina bifida and its operative treatment the reader is referred to Hildebrand's article in the "Archiv f. klin. Chirurgie," Bd. xlvi, Heft 1.

PART VII.—UNCLASSIFIED T

CHAPTER I.

ACUTE ABSCESS.

Acute abscesses ought to be drained as early a diagnosis. The operation should be performed u precautions. This is important because of the da increased or mixed infection, *e. g.*, grafting a stre a staphylococcic infection.

Local anæsthesia is usually sufficient to pre When an abscess is superficial, pass the knife stead skin and subjacent tissues until pus is reached. T done at the most prominent or most dependent part As the knife is withdrawn the wound may be enla guide as to the size of the opening to be made is surgeon's fingers. In a small and not deeply situa little finger can explore the whole cavity; in la the index finger must be used. The opening shou sufficient size to admit the exploring finger.

When the abscess is deep, Hilton's method c safe and excellent. An incision about one or on inches in length is made over the most prominent part of the swelling. The incision penetrates the fascia. A grooved director, which must not be insinuated through the tissues in the direction of pus flows along its groove. The point of a narrow stat or blunt-pointed scissors is passed along the di abscess cavity. The blades of the instrument ar and made to dilate the opening to an appropria

quently counteropenings are required. Such may be made by passing the point of a hemostat into the abscess and pushing it out through the tissues until the skin is reached. The skin elevated by the point of the forceps is divided, the blades of the forceps are opened to enlarge the passage, a drainage-tube is seized by the forceps, and as the instrument is withdrawn, the tube is pulled into position. An abscess having been opened, its cavity ought to be douched thoroughly with warm water or a mild antiseptic solution until the solution returns clear. Any gross sloughs or masses of débris should be removed with forceps, finger, or sharp spoon. The last-named instrument should not be used too vigorously lest nature's defence against absorption, viz., granulation tissue, be too thoroughly removed, or violent hemorrhage or persistent oozing started.

Drainage-tubes must be inserted through the openings. Young practitioners often delight in the use of tubes about the size of a crow-quill; such are almost useless, as the fluid to be drained is thick and speedily chokes them. Rubber tubes which vary from the size of an ordinary lead-pencil to that of the little finger are the best; no object is to be attained by using sizes much larger. The external end of the tube must be kept from slipping into the wound, either by being stitched to the skin or by having a large safety-pin passed through it.

Dressings.—Ordinary, voluminous antiseptic dressings must be applied in such a manner as to collect the discharge and at the same time exercise elastic pressure on the abscess so as to keep it collapsed as much as possible and prevent reaccumulation of fluid.

PSOAS ABSCESS.

Treves' Operation.—The patient is placed on his side with the diseased side uppermost. Under the opposite loin there is placed a sand-bag. An incision 2½ to 3 inches in length is made parallel to and beside the outer edge of the erector spinæ muscle (*i. e.*, about 3 inches from the spinous processes). The middle of this cut corresponds to a point midway between the last rib and the

iliac crest. The dense aponeurosis covering the erector spinæ is divided throughout the whole length of the wound. The outer edge of the muscle is demonstrated and then strongly retracted towards the spine. This exposes a layer of fascia (middle layer, fascia lumborum) which covers the quadratus lumborum. By palpation find the transverse processes of the lumbar vertebræ and divide the fascia as close to them as possible. The thin quadratus lumborum muscle now comes into view, and according to Treves it must be divided close to a transverse process. The next tissue met is the psoas muscle, and when some of its tendinous fibres have been divided close to a transverse process, the finger can be "introduced beneath the muscle and gently insinuated along the process until the anterior aspect of the bodies of the vertebræ is reached."

FIG. 552.

In cases where there is a large psoas abscess the patient is almost always much emaciated and the tissues over the abscess are thin, so that after the quadratus lumborum muscle has been exposed, a grooved director may be insinuated into the abscess cavity and an entrance gained by Hilton's method. Having gained access to the abscess, it is thoroughly douched with hot water or a hot antiseptic solution. The writer often uses a sherry-colored solution of tincture of iodine in hot water. The lining membrane of the abscess is to be scraped away with finger-nail and sponge (Treves) or with the irrigating curette (Barker) (Fig. 552). This must be done cautiously, as the anterior wall of the abscess is usually thin. All pockets leading from the main abscess are explored and opened up by the finger. All accessible portions of the spine are palpated, and if any tuberculous nodules are found they are, if possible, to be removed. Having douched and cleaned and douched again, until the fluid returns clear, the cavity is dried, two or three ounces of iodoform emulsion are thrown into it, and the wound is closed without drainage. The abscess may recur and require a second operation.

The after-treatment consists in rest under hygienic conditions, and must be carried out for many months.

The great advantage of the Treves operation is the access it gives to the spinal column—to the focus of the disease.

Should the abscess have opened of itself in the thigh, it must be treated on the ordinary surgical lines, *i. e.*, counteropenings must be made to provide efficient drainage.

CHAPTER II.

METHODS OF DRAINAGE.

The collection of fluids in dead spaces in wounds is potentially dangerous, and hence drainage should be provided for such spaces. Collections of pus or other noxious fluids in any part of the body require removal, usually by means of drainage. Drainage in its simplest form is exemplified by the open treatment of wounds; here absorbent dressings are applied directly to the wound surface or cavity and absorb all exuded fluids as soon as secreted. Where dressings cannot be applied directly to the secreting surfaces, the secretions must be guided to the dressings. According to the nature and surroundings of the fluid to be drained, the method of drainage provided must vary. For such fluids as serum, capillary drains suffice; for thick pus, tubular drains are essential. When a collection of pus is evacuated through the peritoneal cavity, the method of drainage must provide protection to that cavity, hence a combination of tubular or capillary drainage with protective packing becomes necessary. The following are the principal means of drainage:

(A) **Capillary Drains.**—1. *Horse-hair; silkworm-gut; cat-gut.* A few strands of these materials, in a bundle, act as an efficient drain for small quantities of serous exudates.

2. *Gauze or wick.* A strand of absorbent gauze or a portion of lamp-wick may be used as a capillary drain, but if these are left in place too long, fluids readily coagulate in their meshes, and instead of draining, they act as a plug to prevent drainage.

3. *Cigarette drains* consist of gauze surrounded (Fig. 553) by a sheet of thin rubber tissue which enhances their efficiency and prevents the gauze becoming adherent to surrounding structures. Instead of rubber tissue the gauze may be surrounded by a split rubber tube (Fig. 554).

(B) **Tubular Drains.**—1. *Rubber tubes.* Very small tubes are useless, as they become plugged by coagulated discharges. The most useful are those the size of an ordinary lead-pencil or of the little finger. It is rare that larger tubes are necessary, and then only in the form of split tubes covering a wick of gauze. The tubes must be perforated laterally and their distal ends should be trimmed in a fish-tail fashion (Fig. 555). The tube may be prevented from slipping into the body by being stitched to the skin or provided with a guard in the form of a safety-pin.

FIG. 553.

FIG. 554.

2. *Split rubber tubes* are the ordinary tubes split up one side. The split renders the tubes less rigid and less liable to cause pressure necrosis.

3. *Dressed drains* consist of a rubber tube surrounded by a few layers of absorbent gauze (usually iodoform) (Fig. 556), the gauze being in turn covered by thin rubber tissue. The dressed is practically a cigarette drain with a tubular core. They are of great value, especially in abdominal surgery.

4. *Rigid tubes of glass, hard rubber, celluloid,* etc., are often employed. These may be provided with a collar, made from a segment of rubber tube, through which a safety-pin or stitch may be inserted to provide (Fig. 557) against the slipping of the tube into the wound.

Fig. 556.

(C) **Combined capillary and tubular drainage** may be effected by surrounding any of the ordinary capillary drains with a tubular drain, *e. g.*, a rubber tube containing a bunch of silkworm-gut threads.

(D) **Absorbable Drains.**—The use of catgut as a capillary drain has already been noted. Neuber suggested tubular drains of decalcified bone, and Macewen introduced the inexpensive chicken-bone drain.

Fig. 555.

Preparation of Chicken-bone Drainage-tubes.—Clean the flesh off the tibiæ and femora of chickens (cooking the chicken does not injure the bone). Soak in a 20 per cent. solution of hydrochloric acid until soft. Cut off the articular ends of the bone with scissors. Raise the endosteum at one end and push it through to the other extremity along with its contents. Sterilize by boiling

Fig. 557.

in a saturated solution of ammonium sulphate. With sterile water or antiseptic solution wash off the sulphate of ammonium. Preserve in alcohol or in a solution of iodoform in alcohol or ether and alcohol. These tubes last for about eight days in the tissues. If greater durability is desired (*e. g.*, when they are used to drain cerebral abscesses), soak in a sterile solution of chromic acid.

Macewen recommends that when bone drains are used in fresh wounds they be threaded with horse-hair to prevent plugging with clotted blood and to encourage capillary drainage. After a day the hairs are removed, leaving the tube patent.

CHAPTER III.

NERVES.

NERVE SUTURE; NEURORRHAPHY.

Primary Neurorrhaphy.—When a nerve of any impor is divided, it ought to be at once sutured. The favorite s materials are silk and fine chromicized catgut. The needles should be as fine as possible and either round or flat, to a needless division of axis-cylinders.

Direct Suture.—The stitch includes in its bite the shea well as the body of the nerve. Such a stitch must be supp by sutures involving the sheath alone.

Indirect Suture.—Fibrous tissue around the divided ner united by sutures and thus holds the ends of the nerve in a sition.

It is well to combine the indirect and direct methods there is loss of nerve substance and a gap exists between the they may be brought together by stretching their trunks, or fo material may be implanted to bridge the gap.

Secondary Neurorrhaphy.—A nerve has been divide injury; recovery from the injury is complete, but the nerv never been united; to effect union, the operation of secon neurorrhaphy is necessary.

Step 1.—With, or preferably without, a tourniquet mak incision along the course of the nerve at the point of injury. dissection expose both proximal and distal portions. The fo will be found bulbous, the latter probably filamentous. I ends cannot be found readily, enlarge the incision, expose trunk above and below, and follow it to the site of injury. E intervening scar tissue.

Step 2.—Vivify the ends of the nerve by paring with a s

knife. Never sacrifice more than ¼ inch from either end in this procedure. It is unnecessary to remove all the bulb on the proximal stump (Bowlby, Jacobson). Unite the ends by suture, if necessary, stretching the proximal portion of the trunk to obtain apposition.

The methods of applying sutures are practically the same as those used for the repair of tendon. When apposition is impossible, the remaining gap may be bridged over in the same manner as in the case of tendons.

Implantation of nerve from the human body or of the sciatic nerve or spinal cord of other animals (*e. g.*, rabbits) has given gratifying results. Glück recommends placing these grafts inside decalcified bone tubes and tucking the vivified stumps of the nerve to be united into the open ends of the tube, there fixing them with sutures. Formalinized portions of arteries may be used in place of the bone tubes.

The favorite method of bridging the gap is by means of several strands of chromicized catgut (distance sutures). In order to unite severed nerves several surgeons have successfully excised segments of the humerus or of the forearm bones, thus shortening the limb and attaining their aim.

As in the case of tendon, so with nerves, various methods of transplantation may be used. Dumstrey ("Centralblatt f. Chir.," 1902, p. 376) describes a case where the ulnar nerve was extensively destroyed more than two years previously by a fracture of the elbow. He implanted the peripheral portion of the nerve into a button-hole in the median nerve, and inserted "distance suture" of catgut between the proximal portion of the ulnar and the same point in the median. Within three months there were a notable return of sensation, a beginning of motion, and a loss of previously existing contracture.

A case of extensive destruction of the radial nerve is reported by C. Sick and A. Saenger ("Archiv f. klin. Chir.," liv, 271), who operated as follows: (1) Exposure peripheral portion radial nerve in forearm. (2) Exposure median nerve in forearm through the same incision. (3) Splitting of a flap, with base up-

wards from the median nerve. (4) Conduction of th under the muscles and suture of it to the exposed portion radial nerve. After several months there was no improv but when one and one-half years had elapsed the paraly almost entirely disappeared.

Robert Kennedy (quoted by Cushing), in a case of sever spasm, divided the facial nerve, uniting the proximal extre its distal portion to the partially divided spinal accessory The result was perfect.

Harvey Cushing ("Annals of Surgery," May, 1903) : a case in which the facial nerve was destroyed near the mastoid foramen. After the original wound (pistol woun thoroughly healed, the following operation was performed:

1. Incision along anterior border sterno-mastoid.

2. Exposure spinal accessory nerve at point of entry int surface of sterno-mastoid, about two inches below the tip mastoid.

Exposure distal segment of facial nerve by incising th terior border of the parotid gland in a line parallel to a rectly under the original skin-incision. If this cut be carefully, one of the main branches of the nerve is certain encountered and can be followed back by blunt dissection *u* (Fig. 558) isolating the nerve itself.

3. Square division of facial nerve close to the scar tissue ing at point of original injury.

4. Division spinal accessory nerve at point of entry int muscle.

5. Approximation of the two nerves, without tension, ov posterior belly of the digastric muscle. Suture.

6. Closure of wound.

Improvement was noted after an extraordinarily short The ultimate result was most gratifying.

After neurorrhaphy or nerve transplantation complete re the parts, *without tension on the line of suture*, must be maint until union is complete. The subsequent treatment consis massage, electrical stimulation, and proper gymnastics. E

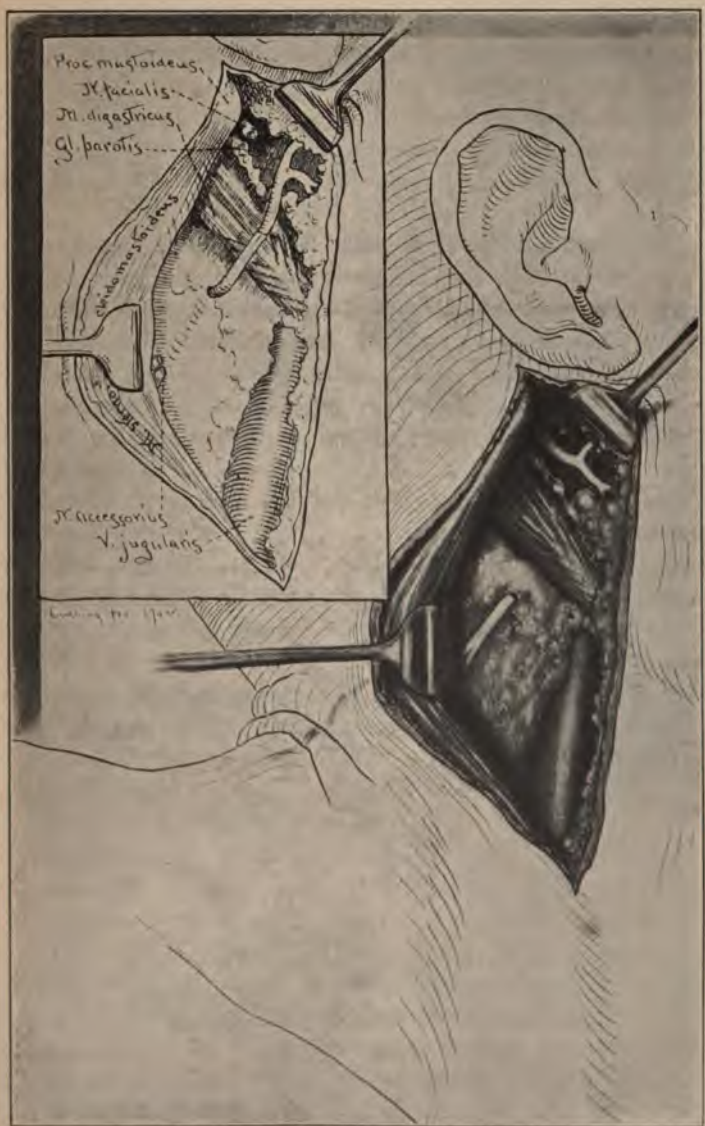

FIG. 558.—(*Cushing, "Annals of Surg."*)

lent function is sometimes obtained long after all hope has been abandoned. Sensation may be expected tc before motion, generally after the lapse of two to fou Motion is rarely obtained until months after operation. cases of neurorrhaphy (Tillmanns), 67 per cent. were su Of these 76 cases, 33 were secondary operations with 24 successes.

Dislocation of Ulnar Nerve at Elbow.—Momburg (f. klin. Chir.," lxx, 215) has shown that the ulnar nerv quently thrown out of its groove on the inner epicondyle, es during elbow flexion; that this is entirely unimportant un nerve is irritated; that when there are irritation and pain, t cure is by operation. Several operations have given good Croft sutured the nerve to the triceps tendon and the tissue covering the bone. McCormac isolated the ner fixed it by loops of kangaroo tendon to the triceps tendon eral surgeons have formed flaps of fascia or even of bo periosteum (from the epicondyle) and with these cover nerve in its groove. Momburg splits the triceps tendon a of the muscle longitudinally; at the upper end of the s divides the muscle to the ulnar side of the split, pulls the fl formed around the nerve, and sutures the muscle in its position. The nerve now passes through the triceps and be dislocated.

CHAPTER IV.

PRINCIPLES OF PLASTIC SURGERY.

Plastic operations are such as are undertaken to close up or fill defects resulting from errors in development (hare-lip, etc.) or from the destruction of tissues by disease, operation, or accidental injury. While plastic operations are applied to each and every kind of tissue (bone transplantation, tenoplasty, neuroplasty, etc.), yet in most of them the skin plays the chief rôle.

Do not undertake plastic operations in the debilitated or in those with active disease present (*e. g.*, suppuration, syphilis, etc.).

The two main principles at the base of all plastic work are: (*a*) Proper preparation or vivification of the tissues to be united; (*b*) thorough relief of tension. Failure to carry out these principles leads to certain disappointment.

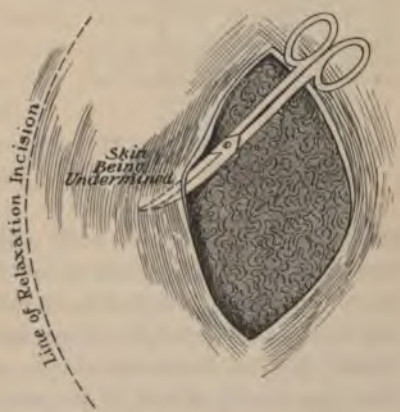

FIG. 559.

When the defect is oval but not very extensive and the neighboring skin is not firmly bound to the deeper structures, the edges of the oval may be brought together directly and sutured. If on attempting approximation *tension* makes itself evident, this tension must be relieved. Tension may be relieved by burrowing with knife or scissors between the skin and the deep fascia, thus undermining the skin all around the defect

(Fig. 559). In some localities, *e. g.*, the pectoral region, large defects may be thus obliterated. Often this burr must be supplemented by making a cut through the skin pa to and on one or both sides of the defect. Such rela incisions should be in positions where their scar will be or less hidden. When the defect is square-shaped, it m closed as shown in Fig. 560. Large defects require other n of treatment, either being closed by skin-grafting or b use of pedunculated flaps of healthy skin, obtained preferal the near neighborhood, occasionally from more remote The skin chosen to form the flaps must be such as to match lost. It would not gratify a patient much to have a succ rhinoplasty performed on him if the hairy scalp was used to s

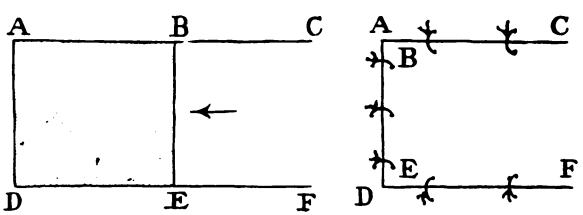

FIG. 560.

the necessary skin for the nose. The objection to many c operations for ectopia vesicæ or for epispadias is that skin ca of growing hair is used to line the new bladder or urethra. less skin is often used to replace lost mucous membrane, healthy mucous membrane can be obtained, such is far b The flaps should consist of the whole thickness of the skin without too much subcutaneous fat attached to them; ought to be about one-sixth larger than the defect they are t and should have a pedicle through which nourishment is f supplied. Twisting of or tension on the pedicle occlude blood-vessels, cutting off nourishment and impeding the na drainage; hence it is necessary in tracing out the flap to do such a position that it can be fixed in its new location wit running these hazards. Part or all of a skin-flap, even wi

good pedicle, and with its raw surface in contact with a corresponding healthy raw surface, often fails to live. After the lapse of a few hours the surface becomes discolored, edematous, blisters form, and death of the tissues takes place. This death is *not* from want of nourishment; it is from want of normal absorption or drainage from the flap. The drainage is of even more importance than the nourishment obtained through the pedicle. Under similar circumstances a flap of skin completely detached from the body and implanted into a defect (Wolf's grafts) lives and does not show the above phenomena. This is due to the fact that there is no damming up of lymph in the detached portion of skin. The grafted skin soon becomes united to its new bed, thus obtaining a sufficiency but not an excess of nourishment. C. H. Mayo scarifies the surface of flaps which are provided with pedicles, thus providing for immediate lymph drainage and avoiding the dangers of necrosis from lymph stasis. This scarification need not be deep; mere scratches suffice.

FIG. 561.

Sometimes flaps are provided with two pedicles—"visor-shaped" flaps. A good example of this variety is seen in Regnier's operation for cancer of the lower lip.

Fear may be entertained as to the viability of a flap if it is transferred to its new site as soon as it is formed, and thus in some cases it is wise to trace out the flap, separate it from the deep structures, but leave it attached at both ends; the bridge of skin thus formed must be kept separated from the subjacent tissues by a layer of oiled silk. After about two or three weeks one of its pedicles is divided and the flap put in place (Fig. 561). This plan (Croft's) is specially suitable when the flaps required are long and narrow.

Instead of pedunculated flaps, areas of skin entirely detached from their normal connections may be used. This is truly skin-grafting. The grafts may be obtained from the patient himself, from a recently amputated healthy limb, or from oblig-

ing friends. Grafts obtained from animals (rabbits, frogs) have been employed, but when used after the Thiersch method, even if they have adhered to the raw surface, they have not reproduced epithelium and have been ultimately absorbed.

Wolf's Grafts.—Wolf, of Glasgow, devised the following method of repairing recent defects, especially in the eyelids:

On some suitable region—the forearm, inner side of upper arm, or thigh—trace with the scalpel an area of skin at least one-sixth larger than the defect to be filled and of suitable shape. Quickly and completely separate the flap outlined from the subjacent tissues. With the scissors carefully remove all fat from the under surface of the graft; in fact, trim this surface until the pale, deep surface of the cutis vera is visible. Fit the graft into the defect and hold it accurately in place, either by a few fine sutures or by suitable dressings. In the repair of defects in the eyelid the writer has often seen the Wolf graft sutured in place and protected by a few layers of gold-beater's skin, which, when dry, acts as an efficient splint to the part.

Grafts such as the above are usually employed to cover raw areas resulting from operations and not to cover granulating surfaces. It is of prime importance that hemorrhage be completely stopped, otherwise effused blood will lift the graft from its bed and prevent adhesion.

Thiersch's Graft.—Thiersch suggested the use of grafts consisting of epidermis, corresponding in thickness to the covering of a blister and cut from some suitable region in as large strips as possible. This is the most common and convenient method of skin-grafting. The grafts may be applied to a fresh wound, *e. g.*, open wound left after amputation of the breast, or to any clean granulating surface. When a granulating surface is to be covered by grafts, it must be prepared by thorough cleansing and the removal of exuberant granulations by means of rubbing with gauze or by the sharp spoon. All bleeding must have ceased, whether the wound is recent or granulating. If oozing of blood persists, the wounded surface must be covered by a protective layer of rubber tissue, silver-foil, or such like material, over which

sterile gauze is applied, and the skin-grafting put off until the next day.

The grafts are generally obtained from the inside of the thigh. If the skin to be employed is hairy, shave the hair. As the portion of epidermis to be taken is too thin to contain any hair-bulbs, no hair will be grafted, no matter from what region the graft is obtained. Cleanse the area selected. With the hands, McBurney's tractor, or a paper-knife, make the skin tense. Shave off the thinnest possible layer of epidermis with a very keen razor, moistened with salt solution (Halsted uses an amputation knife). This forms the graft, and should be as large as possible. Carry the graft, lying in folds on the razor blade, to the wound. Keep it moist with salt solution. Hold the sharp edge of the blade close to the wound. With a needle pull the end of the graft gently on to the wound, temporarily fixing it there; as the blade is slowly pulled away parallel to the wound the graft smoothly slips off it and lies flat on the wound. If there are any little folds in the graft, get rid of them with needles in the same manner as is done when spreading sections of tissue on the slide for microscopic work. Sometimes if the graft becomes tangled on the razor blade it is well to put it in a basin of salt solution and float it on to a piece of oiled silk. The oiled silk with the graft lying smoothly on it is laid (with the graft under) on the wound, the edge of the graft is held in place on the wound with a needle, and the oiled silk removed gently, leaving the graft in the position desired.

When the whole wound is covered with grafts, place over them strips of rubber tissue or of silver-foil, and outside this the ordinary gauze dressings. The dressings ought, if possible, to remain unchanged for a week; when they are removed, the rubber tissue or silver-foil prevents them pulling the delicate epithelium away with them. No antiseptic lotions ought to be employed, only salt solution. The same kind of dressings must be applied until the healing process is complete. Very large surfaces can be made to heal in a short time by the Thiersch method of skin-grafting.

Denuded areas on the hand or forearm may be covered with

skin by the following efficient but distinctly uncomfortable method: If the defect is on the back of the hand or forearm, choose a place on the front of the abdomen or chest where the hand or forearm may lie and be supported without too great strain. Through the skin of the trunk make two parallel incisions and undermine the skin between them, thus forming a flap with two pedicles (Fig. 562). Push the hand under the flap and adjust and suture the flap to the denuded area. Apply dressings, and with adhesive plaster fix the hand and arm to the trunk. When union

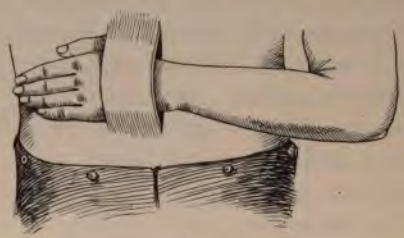

FIG. 562.

has taken place between the flap and the denuded area, divide the pedicles, close the abdominal wound in the usual manner, trim the flap, and complete its union to the denuded area. If the denuded area is on the palmar aspect of hand or forearm, the flap must be made on the back of the trunk. The following diagrams illustrate better than words a few methods by which defects can be filled by means of skin-flaps (Figs. 563 to 567). Special plastic operations have been considered in the sections devoted to the surgery of various individual conditions and regions.

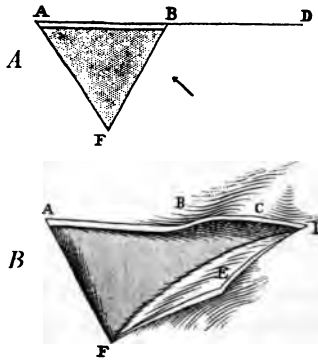

FIG. 563, A, B, C.

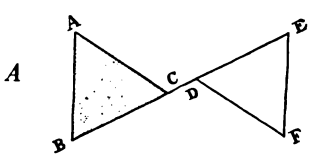

FIG. 564, A B, C.

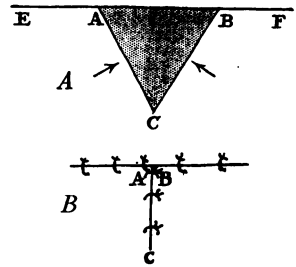

FIG. 565, A, B.

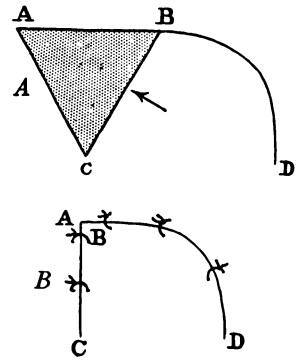

FIG. 566, A, B.

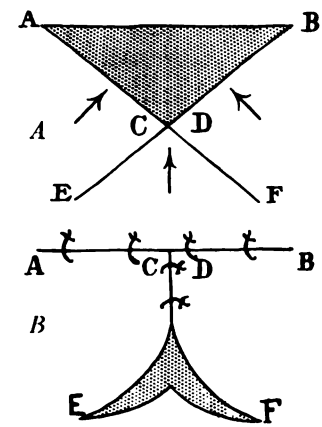

FIG. 567, A, B.

CHAPTER V.

LIGATURES AND SUTURES.

I. Non-absorbable.—The principal non-absorbable ligatures or sutures are: (*a*) Silk; (*b*) Pagenstecher's celluloid hemp; (*c*) silkworm-gut; (*d*) horse-hair; (*e*) wire (silver, gold, aluminium-bronze). All the above materials are strong, of uniform size, capable of being easily and securely tied or fastened, and sterilized by being boiled or steamed.

Silk is the material most commonly used for intestinal sutures and for non-absorbable ligatures. Celluloid hemp (in the smaller sizes) possesses all the advantages of silk, and, in addition, it has less capillarity, and being stiffer, can be readily threaded into fine needles even when wet. These two peculiarities are of great value in operations on the intestine. The want of capillarity prevents, to some extent at least, any infection passing along the thread, as intestinal sutures very commonly include part of the mucosa even when introduced with the greatest care. The convenience of being able to thread a needle with the wet material is self-evident. Celluloid hemp is stronger than silk, but its surface is not so smooth. Thick celluloid hemp ligatures are not so easily drawn into a tight knot as are silk ones and possess no advantage over the latter.

The most convenient sizes of silk or hemp are Nos. 1, 2, 3, and 4. For intestinal sutures and the ligation of small vessels, Nos. 1 and 2 are excellent. No. 4 is used for tying large pedicles.

Preparation of Silk or Hemp.—Wind the thread on glass spools or tubes, preferably in one layer. Boil in water or 4 per cent. soda solution for fifteen or thirty minutes (along with the instruments). Soak in corrosive sublimate solution 1: 1000. The advantage of using the antiseptic solution is that it inhibits the growth of any

bacteria which may accidentally gain access to the ligature during the operation.

Kocher is the most enthusiastic advocate of silk. He prepares his ligatures as follows: Soak the silk in ether for twelve hours; then in alcohol for a like period. Boil for ten minutes in a 1: 1000 solution of sublimate (the sublimate solution must neither be colored nor acidulated). Use the silk directly from the sublimate solution. As pulling thread between the fingers of the operator is liable to infect it, Kocher always wears gloves when tying ligatures, even when he does not wear them for the other steps in the operation.

When silk is to be used for intestinal work, it may be sterilized by steam, and being dry, is easily threaded on needles. If to be sterilized by boiling, the requisite numbers of needles should be threaded beforehand and stitched into a towel in such a manner that they can be easily pulled out but cannot become entangled while being boiled.

Silkworm-gut.—This, the common fishing gut, is prepared from the silkworm when it has got into condition to begin spinning. The material used is, in fact, the silk before it is spun. Silkworm-gut is an ideal, smooth, strong, non-porous, non-absorbable suture. It is easily sterilized by boiling, which at the same time softens it and renders it easy to tie. If used dry, the gut is hard and too brittle to tie. It may be obtained in various sizes, from the thick and very strong gut used by salmon fishers to the extremely fine "drawn gut" of the English dry fly fishermen.

Horse-hair possesses the advantages of fine silkworm-gut, but is better in that its elasticity prevents cutting of the tissues. It is ideal material for fine skin sutures, as it leaves little scar. It is prepared for use by a thorough washing in soap and water and then by boiling.

Silver Wire.—This is the most common suture used for uniting bones. Some surgeons use it extensively for buried sutures. Its ends are easily secured by twisting. Sterilization is effected by boiling. The metallic silver is an antiseptic *per se*.

II. Absorbable Ligatures and Sutures.—(*a*) Catgut; (*b*) tendon.

Catgut.—The most common absorbable ligature is made from the submucous coat of the intestine of sheep. The best catgut comes from Germany and Sweden. The American sheep suffer from some intestinal disease which renders their submucosa useless for the manufacture of catgut. The most convenient sizes of catgut are Nos. 1, 2, and 3. No. 4 is occasionally of service, but is very thick.

Catgut may be used plain or may be treated with some material which renders its absorption by the tissues more slow (chromic acid, formalin). There are a very great number of methods by which sterilization may be effected; only a few of these will be detailed here. Several manufacturers prepare reliable catgut in convenient receptacles, *e. g.*, in hermetically sealed glass tubes, in air-tight envelopes, etc. Such catgut is usually sterilized by dry heat in the fractional method. The process is more or less complicated and will not be described, as simpler and equally efficacious methods are available. The chromicized catgut of commerce is too thoroughly chromicized; it remains too long unaffected by the tissues and should be discarded. The cumol method of sterilization seems to be reliable, but requires considerable experience to be carried out in safety.

Preparations of Catgut.—Wind the catgut in a single layer on glass tubes. In doing this it is very important to rotate the tubes, and, holding the gut tight, allow it to be wound on to the tube. If one twists the gut on to the tube, as it passes through the fingers its fabric is liable to become untwisted and its strength ruined. Fasten the end of the thread so that it will not come undone.

Methods of Sterilization.—(I) Elsberg's method (modified). Make a saturated solution of sulphate of ammonium in water. Boil this solution and see that it is saturated while boiling. Boil the catgut in this for twenty minutes. With sterile forceps place the gut in sterile water or antiseptic solution to remove the sulphate of ammonium. This does not consume more than a minute. Preserve the gut in alcohol or in a saturated solution of iodoform in alcohol and ether. Elsberg before boiling soaks the gut for

twenty-four hours in a mixture of chloroform and ether. This is unnecessary.

II) Claudius' method: (I, KI, catgut). Soak the gut (wound on tubes) for eight days in the following solution: Iodine, 1 part; iodide of potassium, 1 part; water, 100 parts. The gut is now ready, and may be used either directly from the solution or after washing in sterile water or some antiseptic solution. The author prefers using it directly from the iodine solution. It is claimed that the catgut may be kept indefinitely in the solution, but this is incorrect.

Salkindsohn modifies the above in a happy fashion by using a mixture of tincture of iodine 1 part in 15 parts of proof (*i. e.*, 50 per cent.) spirit. Iodized catgut has given great satisfaction to the author.

(III) Saul's method: Put the gut (wound on tubes) into a pot provided with a condenser. Cover the gut with a solution of carbolic acid 5 parts; 90 per cent. alcohol 100 parts. Boil for twenty minutes. Preserve the gut in alcohol or in a solution of iodoform in alcohol or alcohol and ether. Experiment shows that gut, soaked in a culture of anthrax annd covered with grease, is sterilized by the above method after seven minutes of boiling.

(IV) Chromicized catgut: Sterilize the gut by the Elsberg or Saul method. Soak for twelve to twenty-four hours in a sterile watery solution of chromic acid (1: 10,000). Such gut lasts from seven to ten days, according to its size. The strength of the solution may be varied according to the ideas of the surgeon. Preserve in alcohol or in a solution of iodoform in alcohol or alcohol and ether.

(V) Formalinized catgut: Sterilize the gut by the Elsberg or Saul method. Soak for twelve hours in a 1 per cent. watery solution of commercial formalin. Preserve in alcohol, etc. The durability of this gut is about seven to ten days.

The usual method advised for the preparation of formalinized catgut is to soak it for twelve to forty-eight hours in a 2 per cent. watery solution of formalin, wash in flowing water for twelve hours, boil for twenty minutes in water, and preserve in alcohol. Boeck-

man, however, points out that the formalin acting on the gut makes its surface waterproof, that the boiling water does not penetrate the gut, and that, as a consequence, the inside of the ligature is only exposed to a *dry* heat of 212° F., which does not sterilize.

The methods of sterilization here described have all been tested by the author and found satisfactory. In none of them is it necessary to touch the gut with the fingers from the time the sterilization begins until it is being used in operating. Any one of the methods described is as safe as the others. On the whole, the author prefers Salkindsohn's modification of Claudius' plan; it is so very simple and easy, and the iodized alcohol preserves the gut satisfactorily.

Tendon.—The tendons of such animals as the kangaroo, reindeer, and whale have been much used for sutures and ligatures. Many surgeons prefer them to catgut. Sterilization may be effected as with catgut. The main objection to the use of tendon is its expense.

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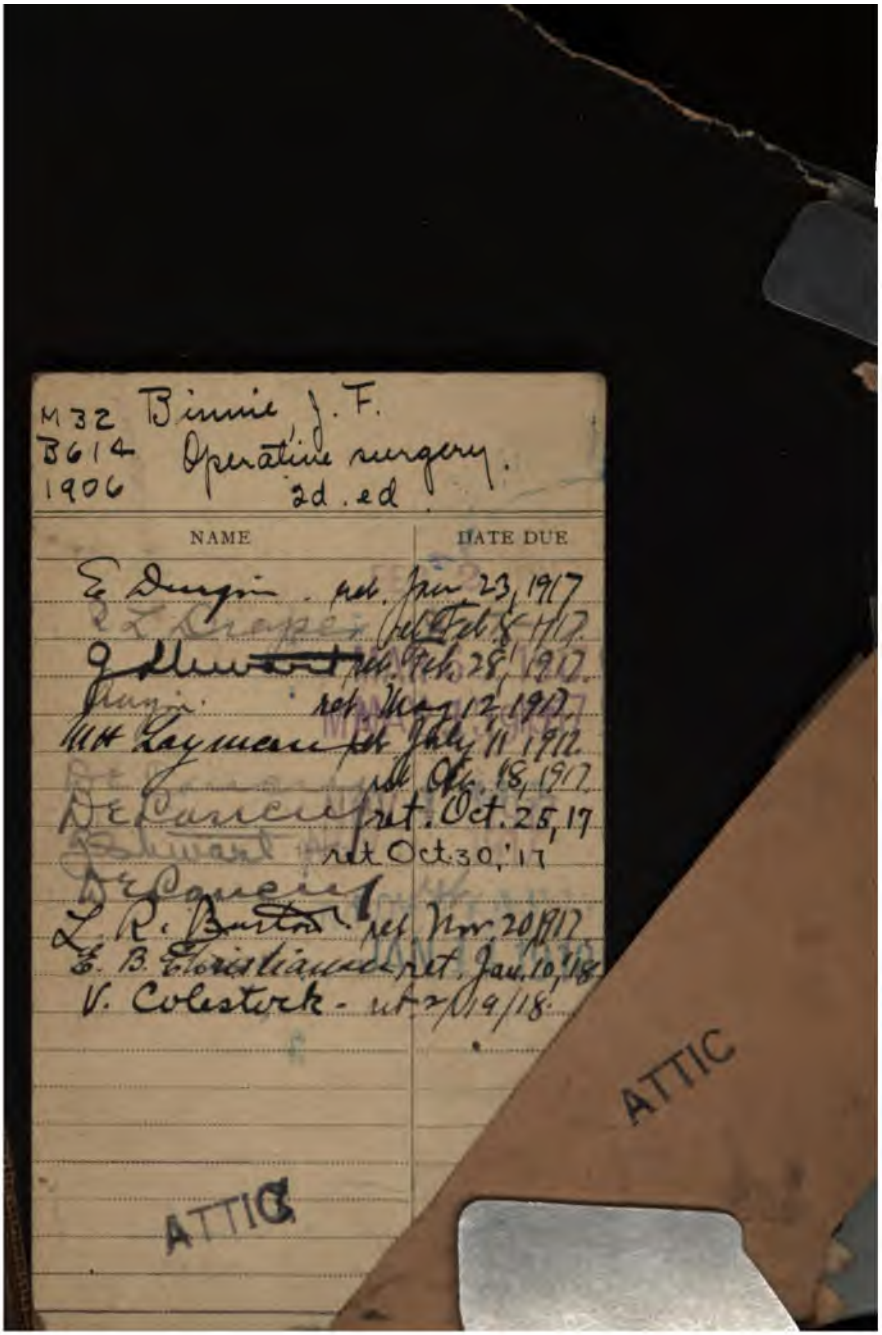
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